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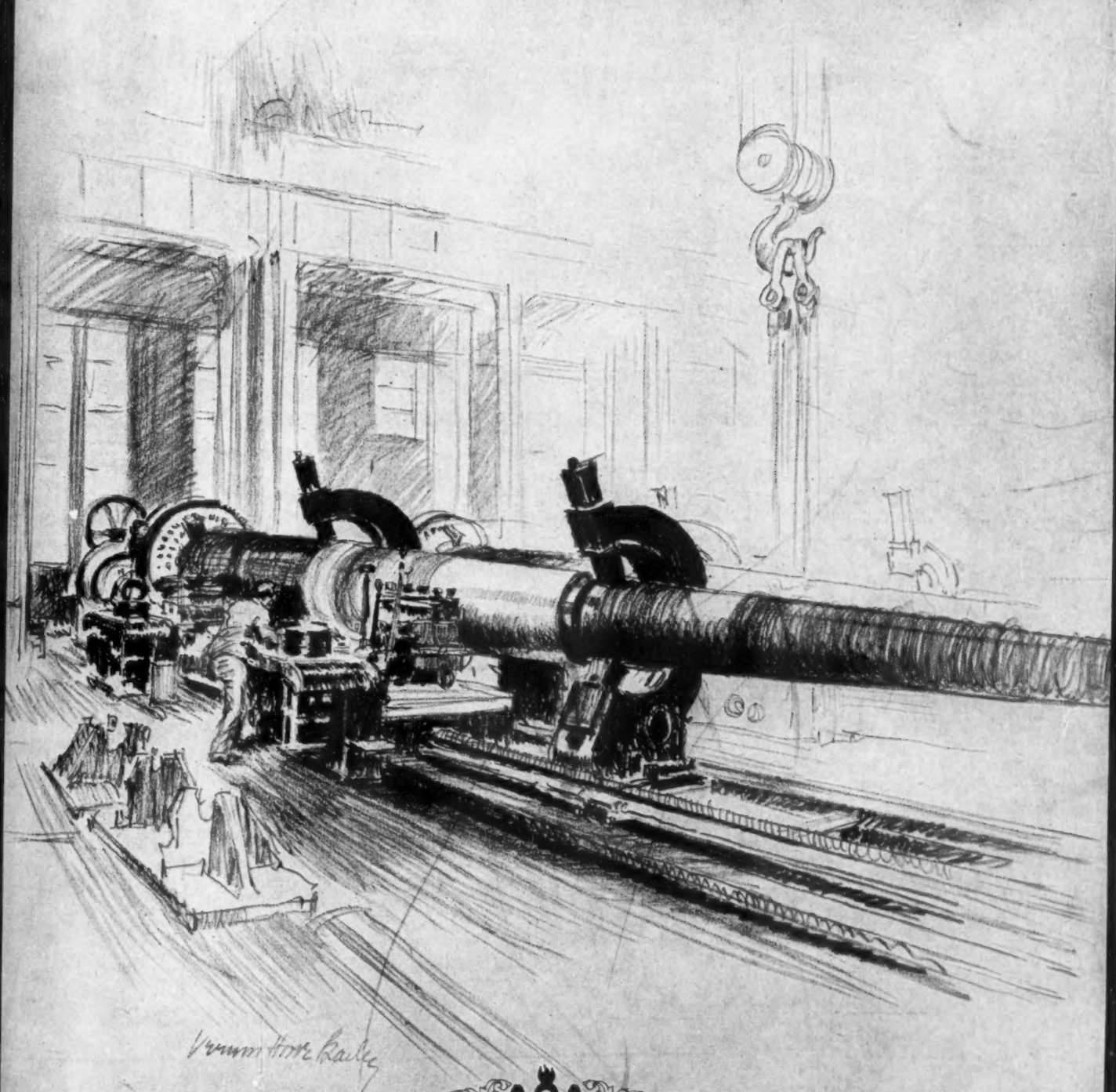

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"Certain patriotic citizens have realized the importance of adequate industrial preparation and have voluntarily organized to assist in this work. The Army Ordnance Association comprises such a group, upon which the War Department leans heavily in carrying on the many activities incident to this type of preparation."

Frederick H. Payne, The Assistant Secretary of War.

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

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The Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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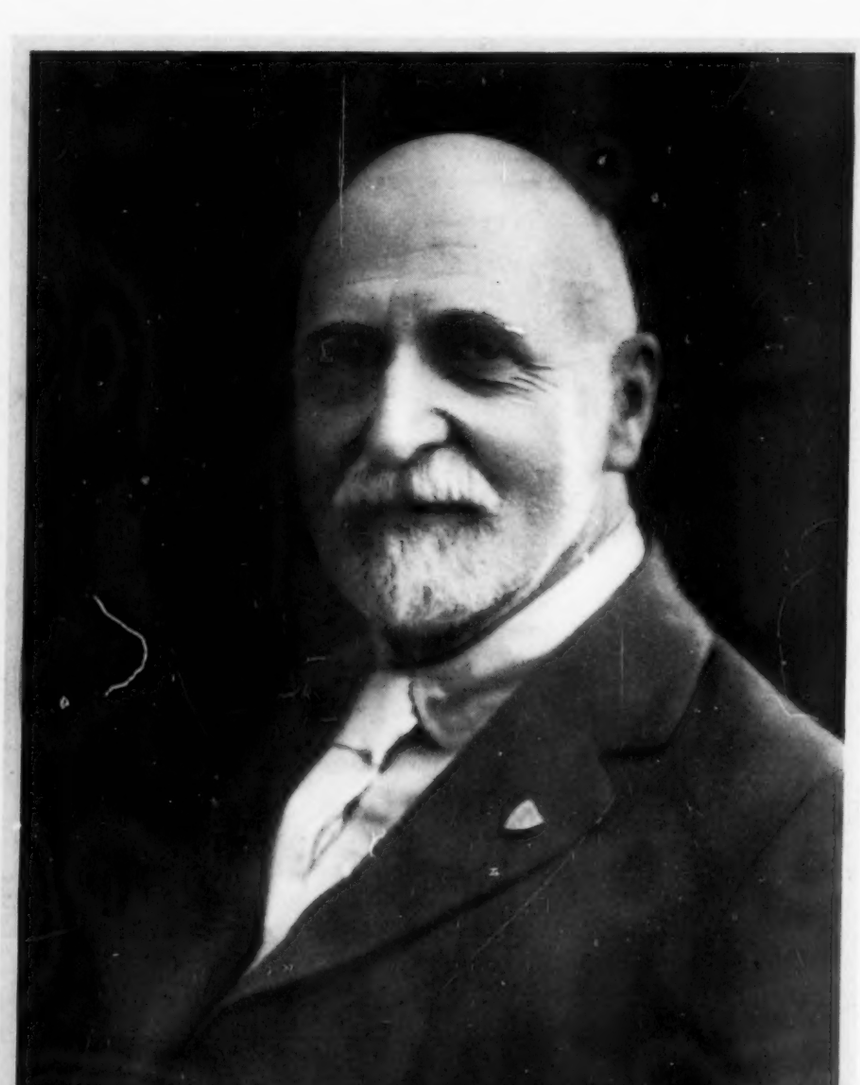

Alex Dow

Recently Appointed Chief of the Detroit Ordnance District

ARMY ORDNANCE

VOL. XII MAY-JUNE, 1932 No. 72

Economy And The Army

A Study of Basic Needs in the Light of Financial Necessity

By Hoffman Nickerson*

PRACTICALLY everyone who has studied national defense regrets to see Army and Navy appropriations cut. It seems obvious that many other government expenditures can and should be cut far more deeply. It is only too easy to compare the three hundred and forty-five millions spent last year on the Army and the three hundred and fifty-seven millions allotted to the Navy with the nine hundred and forty-seven spent on veterans of former wars. Before the American Legion recently reversed its course in demanding bonuses, one was tempted to say that their motto "For God and country we associate ourselves" might appropriately be changed to "For cash and country." The Legion still has a long and shameful grabbing record to live down, but for the moment they have left the evil distinction of chiseling the taxpayer to the Veterans of Foreign Wars. It is instructive to note the rapidly mounting total of "Aids to Agriculture" which last year reached nearly three hundred million—without noticeably benefiting the farmers. It is proper to ask whether Department of Agriculture free pamphlets on the use of spinach or the design of children's rompers are as important as military and naval security?

Unfortunately such argument, though easy, is futile because there are both good and bad reasons which make it certain that the Army appropriation will be cut. The bad reason is part of the increasingly heavy price we pay for democratic government. Human weakness is such that almost any government based on popular election gets gooseflesh whenever there appears an organization making a noise like a block of votes. To their honor, the United States Army and Navy are not in the habit of attempting political blackmail, nor have they the power to do so. The good reason why Defense appropriations will be reduced is that our governmental surplus of over half a billion in 1929 had become a deficit of nearly a billion in 1931. Therefore the harassed and overburdened taxpayer rightly demands that all government departments cut their expenses to the minimum of what is absolutely necessary. The men in every government bureau naturally wish to see their own budget spared and the necessary cuts in Federal expenditure made elsewhere. Therefore the best that can be hoped as to Defense appropriations is that they may not suffer disproportionately through the general retrenchment so imperatively needed.

Since there must be reductions, the friends of national defense should try harder than ever to make certain that the reduced appropriation is wisely spent.

Nothing short of a general survey of our entire national military problem will enable us to judge whether a cut in any one item will do more or less harm than a cut of the same number of dollars in some other item. A familiar figure of speech likens national defense to insurance. A man insuring certain properties, say against fire, takes into account the reasonable and probable risks. To insure against all possible risks, no matter how remote, would soon bankrupt almost anyone foolish enough to try it. Worse still, over-insurance breeds suspicion; when an over-insured building burns, people ask themselves whether the owner himself started the fire.

In an article called "National Strategy of the United States," published in the January-February, 1932, issue of ARMY ORDNANCE, the present writer attempted such a general survey. Therefore let it here suffice that the size, geographical position and naval strength of the United States make invasion extremely difficult. No existing coalition possesses the combined naval and military strength to invade us, and the chances of such a coalition being quickly organized are exceedingly small. Accordingly the United States maintains land forces only to reduce still further the slight risk of invasion, to act as an emergency police, to furnish moderate garrisons to overseas possessions like Hawaii and the Canal Zone, and to serve the contingencies of national policy. Of these four purposes, the last, that is the contingencies of national policy, is clearly subordinate; in the present state of the world and in any future which now seems reasonably probable it is most unlikely that we shall invade either of our North American neighbors or that we shall require large armies for action in Europe or Asia. It is true that our intervention against Germany could not have been foreseen before 1914 and that a German victory over ourselves and our allies would have had grave national consequences. At the same time, on the principle that economy forbids insuring against remote risks, we need not consider contingencies most unlikely to involve our national safety. The business of finding garrisons for overseas possessions is inescapable but requires no great effort, for these garrisons are small. This reduces the matter to emergency police work and security against invasion, for both of which we must adequately provide. Any large outbreak of internal disorder would be a first rate national calamity, and the consequences of invasion, however unlikely, are such that even the slight existing chance of such a thing surely cannot be neglected.

*Author: "The Inquisition, A Political and Military Study of Its Establishment," 1923; "Warfare" (with Spalding and Wright), 1925; "The Turning Point of the Revolution," 1928; "The American Rich," 1930. First Lieut., New York National Guard, 1916; Captain Ordnance Department, U. S. Army, 1917; Duty with General Staff, A. E. F., 1918; Member U. S. Section, Inter-Allied Armistice Commission, Spa, Belgium, 1918-1919.

In the matter of military method, we have a fixed national tradition of maintaining a small permanent nucleus to be supported at need by improvised forces. That general scheme we shall probably retain through any future which we can now foresee. The question is what form the nucleus (that is the Regular Army and perhaps the National Guard) should take, what preparation should be made for raising improvised forces, and what relation between improvised forces and nucleus should be foreseen? Clearly this relation may vary widely; the nucleus may be broken up and distributed throughout the new units as a stiffening for them, or it may be kept together and used separately for the harder military tasks. In 1917-18 we may be said to have distributed the nucleus; in the Revolution we kept the regular units separate; in the Civil War we kept the regular units together but distributed some regular officers among the new formations.

Our land forces today are organized and armed according to the National Defense Act. This foresees the raising of very large improvised forces in which the existing nucleus is to serve—as far as its small numbers will permit—as a skeleton. The novel feature of the Act is the provision for extending that skeleton in peace-time through the Reserve Officers' Corps which is continually being recruited by graduates of the different units of the Reserve Officers' Training Corps at the various colleges and the summer training camps. Except for the successive increments which have built up the Air Corps, the branches of the Regulars, the Guard, and the Organized Reserves are substantially those of pre-war days in their pre-war relations to each other. Infantry is still considered the principal arm, and its two chief auxiliaries are still the artillery and cavalry. The cavalry and artillery are affected by motorization.

GIVEN the situation of the United States, it is clear that the chief assumption of the National Defense Act, that is the raising of enormous improvised forces, is questionable. Such mastodons are unsuited to emergency police work, for which we need a force in constant readiness, able to strike quickly enough to prevent insurrection growing into civil war. The events of 1861 tell us of the evils which we might have spared ourselves had we then possessed such a force. In the matter of invasion, it is true that the huge armies of the last war showed defensive power. Also the vast conscript horde or nation in arms has been typical of serious warfare since the beginning of the democratic era. Therefore if the geography of the world together with the present political aims and military organization of the great powers lent themselves to an invasion of our territory, there would be some reason for preparing the skeleton of an American army of millions. Even then the 1914-18 impotence of conscript armies on the offensive, together with the great power of the new weapons, the plane and the tank, might give us pause. No matter how heavy our military liabilities, and no matter what the chances of our needing a huge army, we might still decide to put much of our money into a permanent, mechanized ground force and an air force.

As matters stand, our military liabilities are slight. We are among the chief naval powers and wide oceans separate our essential territories from every formidable army in the world. The prospect of Philippine independence gives reason to hope for reduction of our strategic liabilities and a corresponding increase in defensive strength. Even if we rule out our Navy, while we have a respectable land force it is wildly unlikely that an army large enough to occupy our western coast will ever be transported across the Pacific Ocean. In Europe England, the chief naval power, has only a regular army, larger than ours it is true but insufficient for an invading force. Although the other two naval powers, France and Italy, are conscript, their armies now serve only for such short terms that they are hardly more than militias. Russia has no Navy to speak of, moreover her new arsenals and war factories have been placed near the centre of her immense territory so that a large scale offensive on her part would create an extremely difficult transport problem. Accordingly the present chance of our suddenly needing an enormous army is so small that it is negligible. With the world as it is, there seems no good reason for believing that our huge and costly "skeleton" will ever be clothed with flesh and blood.

Furthermore those in authority are beginning to appreciate the situation. The opinions of the Hon. Ross A. Collins, are thus set forth in the *New York Evening Post* of February 18, 1932, by the well known journalist Clinton Gilbert: "Ross A. Collins, the new Democratic chairman of the House Committee on Military Affairs . . . has long been an obstacle to big army appropriations. . . . For one thing he regards the cavalry branch of the army as an obsolete instrument. It certainly wasn't of much use in the last war, and some military critics are of the same opinion as Chairman Collins—that it is a showy survival . . . of little present value. He thinks too that it is an extravagance to maintain the heavily officered army that this country has. In fact, our army is a good deal like the comic-opera armies, consisting almost entirely of generals. The theory is that we maintain the skeleton of a larger army. Mr. Collins thinks that four thousand of the twelve thousand commissioned officers on the active list could be retired. He is also against military training in schools and colleges and regards with some doubt industrial mobilization plans."

THE present writer respectfully submits that, except for industrial mobilization, a strong case can be made out for everyone of Chairman Collins' reported opinions.

Let us debate each point as if at a Committee hearing. We shall of course do the Committee the bare justice of assuming that it does not mean to prune at haphazard. On the contrary, we shall take for granted that, besides eliminating what may seem dead wood, its members also intend to clip the living branches according to some plan, leaving the tree in a desirable shape. Thus we have the right to suppose that they are out to fit the various branches of the service to our peculiar military needs as a nation and will bear in mind the relative difficulty of improvising new units within each branch.

First then for possible dead wood. Beginning with the cavalry, it is not true that it was useless in the last war. On the Western Front indeed, once stabilized trench warfare had begun, horsemen had little to do. On the other hand, the Western Front was exceptional in that only in western Europe could a theatre of war so restricted in size support the enormous armies which made highly developed trench warfare possible. In less thinly peopled theatres such as Mesopotamia, Palestine or the Russian Front there was

greater mobility and therefore greater scope for calvary action. It is at least as probable that future American armies will operate in thinly peopled theatres as that they will have to make war among dense populations. Further, cavalry retains certain advantages for reconnaissance. It is not hampered by weather like the airplane and can get more detailed information. It can swim unfordable streams which would baffle armored cars and almost all tanks. It can negotiate obstacles impossible to the armored car, and thread narrow mountain trails where neither wheel nor tractor vehicles can go. Horses can forage whereas motor vehicles depend upon fuel. So much for the pro-cavalry arguments. On the other hand, the battlefield role of cavalry is now almost nil; a mounted man is too good a target for automatic firearms. Its usefulness in reconnaissance has been greatly diminished by the plane, the armored car and the fast tank. Amphibious tanks, able to float, advance and steer in water would reduce cavalry's usefulness in reconnaissance towards a vanishing point, and recent experiments have shown that such vehicles are possible. It is most unlikely that the fate of the United States will ever be decided in regions so deserted or so dependent upon narrow trails as to give cavalry the advantage over tanks. On the ground of expense, horses must eat every day in the year whereas machines need fuel only when under way. In the matter of improvisation, suitable recruits for an enlarged war-time Tank Corps will be increasingly easier to find as compared with experienced horsemen, for every year the number of motor mechanics more exceeds that of riders. Accordingly there seems good reason for a considerable reduction in the cavalry.

NEXT as to our top-heavy Officers' Corps. Those who agree with the author in admiring the soldierly type of character will regret interference with the economic security in which our officers enjoy their modest salaries and allowances. On the other hand, most American families have already been compelled to retrench drastically and now face still worse evils. Accordingly it is not enough to argue that our present numbers in officers are desirable; in order to justify them we must show that they are necessary. We have over twelve thousand active regular officers. In 1914 Imperial Germany had only thirty-six thousand. Who believes that either our national military problem or our ambitions are such as to necessitate an Officers' Corps one-third as strong as that of pre-war Germany? Again, take the question of our numbers in officers as compared with enlisted regulars. Counting small numbers of retired officers and men on active duty and omitting Philippine Scouts, we find over twelve thousand two hundred commissioned officers and a thousand warrant officers to an enlisted strength of a hundred and nineteen thousand. This gives less than ten enlisted men for every commissioned officer. We have twenty-two active major-generals. In the late unpleasantness a major-general's command was a division of over twenty thousand men. Let us generously assume that eight of our major-generals, i. e., more than a third, are on staff duties not involving the command of troops. Dividing the hundred and nineteen thousand enlisted regulars among the remaining fourteen would give each of the latter only eight thousand five hundred men to command, that is a little over a third of a war-time division! Or take the matter of colonels: adding together our hundred and seventy-three colonels and our hundred and ninety-two lieutenant colonels of infantry, gives three hundred and sixty-five. A war strength infantry regiment numbered about three thousand men with one colonel and one lieutenant colonel. Our forty thousand five hundred enlisted infantry would make war strength commands for thirteen colonels and thirteen lieutenant colonels, only seven per cent of those we maintain. Or take the majors of infantry, one thousand three hundred and eighty-one of them, each of whom would have commanded a thousand men in 1918. Our forty thousand enlisted regular infantry are able to furnish war strength commands to only forty, that is less than three per cent of our existing thirteen hundred and eighty-one majors! If that does not make ours a comic opera army, then the present writer has never been to a musical show in his life.

It is true that if there were a sporting chance that we may have to raise an army of millions in a hurry, then some defense for our huge officer surplus could be made. Even then one might argue that it would be better to retire at least half our field officers and spend the money so saved in increasing our enlisted strength. This would strengthen our emergency police force and give our field officers more chance of exercising something remotely like a war strength command. How can our majors fit themselves for the duties of their rank when over ninety-six per cent of the unfortunates lack the chance of commanding a war strength battalion at maneuvers? If, as the writer believes, geography and present world conditions combine to reduce to almost zero the chances of our needing a gigantic army in a hurry; then while these conditions last, our present number of officers seems impossible to justify.

It would be unjust to make the infantry the scape-goat for a general condition. Indeed on the face of the figures the Quartermaster Corps with seven hundred officers and the Medical Department with twelve hundred would seem to be far worse offenders.

THE same general reasoning just applied to the Regular Officers Corps will also fit the citizens summer training camps and the military training given in schools and colleges. While in college the present writer volunteered for the only sort of military training then available, that is in the National Guard. He has always been glad that he did so and believes that he benefited greatly by the experience. As the father of three sons he proposes to do everything in his power to see that they get some substantial training when their turn comes. He thoroughly believes in the physical and educational results of such training. But when one stops talking about the benefits thus conferred on those trained to ask whether the training and maintenance of our present Officers' Reserve Corps is necessary for the national defense, that is an altogether different matter. We now have over one hundred and nineteen thousand Reserve Officers of whom only twelve thousand are members of the National Guard. Of the remaining one hundred and eight thousand nearly twenty-eight thousand are ineligible for assignment or active duty in time of peace. The eighty thousand still remaining are subject to call only with the rank and pay of their grade. By contrast, the National Guard is always available for service. That of each state can be called out by the Governor to help keep the peace whenever necessary.

The entire federalized Guard can be called out and sent anywhere by the President. Therefore if public funds are available for military purposes other than the upkeep of the Regular Army and the Guard, it would seem that they should be spent on these two bodies whose legal obligation to the government is far greater than that assumed by the Organized Reserves. It is perhaps doubtful whether more reserve commissions should be issued except to men who have served or are serving full terms as enlisted men in the Regulars or the Guard. As matters stand, our hundred and nineteen thousand Reserve Officers would provide the absurd total of one officer for every twenty men of a non-existent army of nearly two millions and a half. Absurd may seem a strong word, but in view of the small likelihood of our being invaded, the writer can find no other adequate term.

Regarding industrial mobilization plans the case is altogether different. Any sort of war would inevitably require the coöperation of industry upon a large scale. If 1917-18 taught us anything at all we learned that this large scale coöperation is physically impossible to improvise. One might as well try to build, launch and commission a first-class battleship in a month's time. The thing simply cannot be done. Even although in 1917 many factories had long been at work making arms and munitions for the Allies, our tedious efforts and interminable delays deserve not to be forgotten. Until we are prepared to say that we shall never have to fight another serious war, we negect industrial mobilization plans at our peril. Except a nucleus of trained line and staff officers well practiced in the duties of their rank there seems to be nothing which takes longer to prepare than industrial mobilization.

So much then for possible dead wood in our present system. Clearly, however, neither legislators, taxpayers nor friends of the national defense would or should stop with the elimination of what may seem superfluous. Surely the more important question is to see that the government receives full value for money spent. This raises the question of what form the modern Army should have.

THE free use of machinery is a chief mark of our time. For the purposes of peace, one may question whether machines have added to the general happiness of mankind. It is not only that handicraft is often pleasant both in itself and in the quality of its products; it gives a pleasing, leisurely pace to life. We also note that a handicraft country like France is not subject to economic fluctuations as severe as those which afflict nations more industrialized than herself. But when we turn from the question of human happiness in peace to the means for obtaining victory in war, all must agree that the purpose of an Army is wholly competitive. We have therefore the right to ask whether our present Army organization economizes the taxpayer's money by replacing man-power with machine-power where that can be done? After all, exclusive of retired pay, the pay of the Regular Army is as much as a third of the entire Army appropriation. Even in England where man-power is nowhere near so expensive when compared with materials as it is with us, Brevet-Major B. C. Dening in his book, "The Future of the British Army—Its Duties, Cost, and Composition" (pub. H. F. and G. Witherby, London), has worked out in detail the astonishing economies which machine power could accomplish without demonstrable loss of fighting power. American conditions would make the proportional saving much greater.

Machine power might replace man power in one of three ways: The substitution of automatic weapons for those worked by hand, thus increasing the amount of fire delivered by a given number of men; second the mechanical transport of troops thereby increasing their mobility; third the provision of new automotive devices such as the plane and tank. In the matter of automatic weapons we have made real progress; we have increased our proportion of machine guns and are experimenting actively with automatic shoulder rifles. Unfortunately, however, both of these promise to extend the curse of immobility characteristic of the last war. This is particularly true of the machine gun which is not a true infantry weapon since the gun alone—even without ammunition—cannot be carried for any distance by a single man. Also it quickly eats up a weight of ammunition too heavy to be carried by several men. The automatic rifle itself can be carried but its ammunition supply raises the same difficulty as that of the machine gun. Both must therefore strengthen the tactical defensive while weakening the offensive. Even off the battlefield both increase the dependence of infantry upon animal or mechanical transport. The second point, the mechanical transport of old-fashioned ground troops, offers no great technical difficulty and should be fairly easy to improvise. The transport of troops by motor truck is not altogether unlike the handling of old-fashioned mounted infantry. The truck is much faster than the horse and its riders need no training in horsemanship. On the other hand, it is sharply restricted to bridges and paved roads. Any one truck is harder to conceal than several horses, but certainly no harder to hide than the number of horses sufficient to carry a truckload of men. The tactical problem of parked trucks therefore resembles that of the led horses in a mounted infantry or dismounted cavalry fight. In addition to map maneuvers and staff rides, an occasional field exercise with real trucks, perhaps hired for the occasion, would seem sufficient for peace-time preparation in this regard.

THE importance of the plane and tank is that they favor the tactical offensive and hold out hope of restoring mobility to the battlefield. Both are suited to our national conditions because of our great distances and highly developed automotive industry. We have built up a considerable Army Air Force, taking the necessary personnel from the other branches by successive increments. Adding our Naval Air Force, we are second only to France in air power. On the other hand, the plane has obvious limitations. Although it is able to transport small numbers of men and small quantities of explosives rapidly to a given area, its carrying capacity is limited, its operation is dependent upon good weather, and it is highly vulnerable. It is doubtful what success it will have in attacking any ground objective adequately defended by the new antiaircraft cannon and machine guns. Much nonsense has been talked about its alleged power of direct attack on cities. During the war the damage done was trifling compared with the effort expended, and since then the improvement in antiaircraft gunnery has been out of all proportion to that in planes. Moreover the political disadvantages of a policy of "frightfulness" are enormous; such conduct brought England and ourselves in

against Germany, thereby losing her the war. In general the sweeping claims of air enthusiasts may go the way of the exaggerated predictions made when fast torpedo boats were new to naval warfare. Actual sea fighting has now shown that although the torpedo has modified fleet tactics, it has by no means revolutionized them. The chief naval weapon is still the gun. Just so, time may well show that the plane is only a useful auxiliary to the ground forces which will remain the arbiters of land warfare.

THE future of the tank has roused almost as much controversy as the plane. No one however can deny that each successive improvement in firearms has made the assault more difficult. The trench stalemate of 1914-18 was only the climax of a long development. No gallantry could carry unarmored assailants to victory over the hail of machine-gun bullets. Barbed wire made the situation worse. Even the great German offensives of 1918 were finally halted by comparatively slight resistance. Nothing but the armored vehicle on its own tracks combined mobility, fire power and protection. Further, the new fast tanks recall Napoleon's saying that the striking power of an army, like the impact of a moving body in physics, can be found through multiplying its mass by its velocity. One may quarrel with the form of the statement as a piece of overlogical, schematic, Latin thinking. It is impossible, however, to dismiss its substance as a part of the eighteenth century obsession in mathematics because one can test its truth by watching almost any form of physical combat. Who has not seen a lighter, quicker moving boxer escape punishment from a stronger opponent by his adroitness and finally wear down the heavier man by a succession of comparatively light but well planted blows? Military history is crammed with instances of the strategic and tactical advantages of superior speed. Now that the tank adds protection and fire power, its value is hard to dispute. While antitank weapons exist, they cannot be concentrated rapidly enough first here and then there to meet the threat of tank attack unless they themselves are caterpillar mounted; hence the tank seems the only answer to the tank. Immobility behind an all-around barricade of antitank guns will never win a war.

Moreover the fast tank is peculiarly suited to dealing with possible invasion of our vast continental territory. The elder Moltke once said that the strongest form of war is strategic offensive combined with tactical defensive. The first installment of an invading force to reach our shores would presumably fortify a large bridge head or debarkation point on which the remaining installments could land securely. Our success would then depend upon our power to concentrate rapidly and strike hard before the entrenchments and antitank devices of this debarkation point were fully organized. Whatever vague generalities may be heard from Geneva describing the tank as an "aggressive" weapon, it would seem an ideal arm in the hands of our small nucleus of first-line ground troops for their mission of dealing with possible invaders of our territory.

OUR slowness and uncertainty in building up our tank force and in dealing with mechanization are all too well known. The one excuse seems to be military conservatism. Within limits this is an excellent thing; the soldier rightly hesitates to give up methods which have stood the test of battle, exactly as the sailor clings to ships of a sort he knows to be seaworthy. At the same time the sailor's conservatism has not prevented the substitution of steam and steel for sails and wood. American military conservatism has not prevented the growth of our strong Air Corps. It is only in the matter of tanks that we lag behind, obstinately refusing to save the taxpayer's money by substituting machine power for man power.

An experimental mechanized force was indeed organized over a year ago, and it appeared that the War Department was beginning to understand the possibilities of the new fast tanks, especially the Christie. Clearly a machine which can go seventy miles an hour on wheels and over forty on its caterpillar tracks cannot be treated as an auxiliary infantry weapon and should become the nucleus of a new, mobile arm. Clearly again, such an arm will require close artillery support only to be had from guns on self-propelled caterpillar mounts. All this, together with necessary details of mechanized organization and tactics, seemed to be going forward well. But unfortunately this hopeful and long delayed progress has been allowed to sputter away for want of intelligent and energetic support from the Department. One is reminded of the fabled Sergeant-Major of the British Grenadier Guards who said on the day of the Armistice "Thank God this mussy business is over and now we can go back to real soldiering like mounting the Guard at Buckingham Palace!"

IF resistance to invasion were the one chief purpose of our Army, one might go so far as to argue for the abolition of some of our regular infantry units. Since infantry is not so hard to improvise as an air force, a tank corps, or an artillery branch, the duty of furnishing it might be left to the National Guard and to such Organized Reserves as may survive the pruning knife of financial economy. The fact is however that at present the chances of internal disorder seem at least as great as those of invasion. For emergency police work you need infantry. They are necessary for patrolling, for entering buildings to make arrests, and so forth. Accordingly the requirements of police duties join with military conservatism in persuading us to keep up a respectable regular infantry force.

But when we think not of riots but of battles we might do well to remember the British Admiral recently quoted by Liddell Hart. Hearing of the Monitor-Merrimac fight, the Admiral said: "Henceforward the man who goes into battle in a wooden ship is a fool and the man who sends him there is a scoundrel." In terms of the butchery of 1918, who will deny that the unarmored man who charges a machine gun is a fool and the government who orders him to do it is a scoundrel?

If the foregoing summary be correct, then the formula for combining economy with national security should be as follows: No clumsy and expensive skeleton of an enormous army utterly unlikely ever to be required. A well balanced Regular Army and National Guard, armed and equipped in modern fashion with machine power supplementing man power, especially a good sized Tank Corps with a due proportion of artillery on self-propelled caterpillar mounts. Let the Reserves be organized first to fill out the Regulars and Guard in an emergency. Then and only then, with what financial surplus is available let independent reserve units be contemplated.

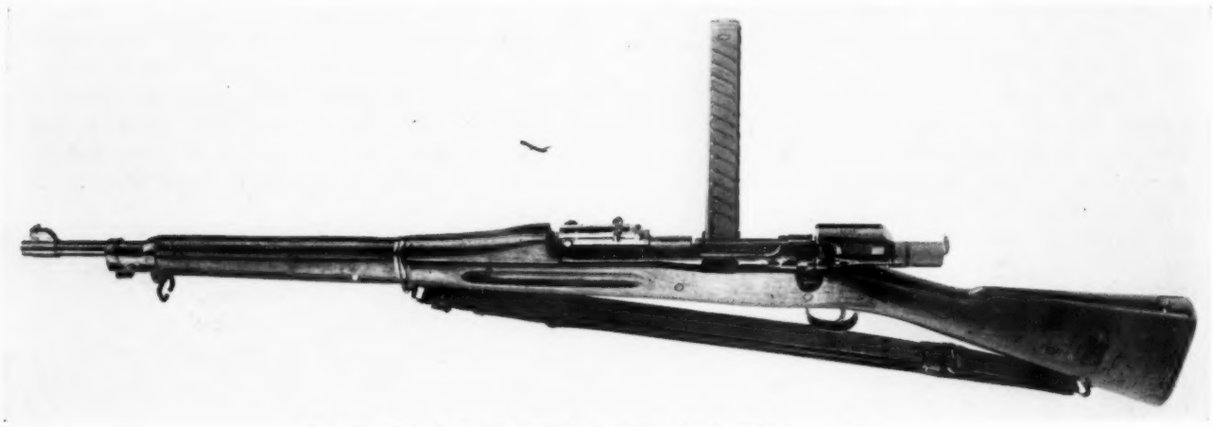

Fig. 1. The Springfield Rifle Fitted with the Pedersen Device.

Our War Secret—The Pedersen Device

The Springfield Was to Be a Miniature Machine Gun in 1919

By J. S. Hatcher*

JUST as the greatest advances in industry as regards new designs and improved methods of manufacture have been produced under the spur of a great industrial crisis, such as the present depression, so have most of the great innovations in war weapons been produced under the stress of some major conflict, when the entire mind-power of the nation has been concentrated on winning the war.

Most of these war inventions have begun their existence as carefully guarded secrets. In those cases involving a general idea of warfare instead of a specific design, the idea will become the property of the enemy and of the world at large as soon as it is disclosed by use in battle. Anything of this nature would be kept a profound secret during the time that preparations were being made to use it on a large scale. Then, after it was in readiness to use, it would still be kept secret until the psychological moment arrived to gain a decisive advantage by surprise.

An outstanding example of the secret preparation and sudden employment of previously unused method of warfare combining surprise and terror in the highest degree, is the first gas attack of the World War at Ypres on April 22, 1915. Of it Field Marshal Sir John French stated: "Following a heavy bombardment, the enemy attacked the French Division at about 5 P. M., using asphyxiating gases for the first time. Aircraft reported that at about 5 P. M. thick yellow smoke had been seen issuing from the German trenches between Langemarck and Bixschoote. What follows almost defies description. The effect of these poisonous gases was so virulent as to render the whole of the line held by the French Division mentioned above practically incapable of any action at all. It was at first impossible for any one to realize what had actually happened. The smoke and fumes hid everything from sight, and hundreds of men were thrown into a comatose or dying condition, and within an hour the whole position had to be abandoned, together with about fifty guns. I wish particularly to repudiate any idea of attaching the least blame to the French Division for this unfortunate incident."

The strangeness of this new terror from the air wrought the utmost confusion among the allied armies at that point until the character of the weapon became known and some methods of protection were devised. Men attempted to save themselves by burying their mouths and nostrils in the loose earth or by holding handkerchiefs or rags over their faces.

Here the Germans just missed gaining a huge success by the use of an entirely new method of warfare. They had but to exploit the attack fully to break through to the Channel ports, but failed to do so because the master mind behind this deadly innovation was that of a chemist, not that of a soldier. Had the officers who directed the use of this new horror had as much confidence in its effects as did the chemists who conceived it, they would very likely have been prepared to launch the first gas attack with full confidence and take full advantage of it instead of trying it in a more or less skeptical and tentative manner.

Immediately the first attack had been launched, the secret was out and the opportunity for success through the aid of mystery and terror was gone forever, for all allied forces received word at once of what to expect and how best to protect themselves. That very night thousands of women throughout the allied countries were making simple gas-masks—a pad of gauze to be wet with a protective solution and tied over the face.

AN entirely different kind of war secret is the weapon or device whose existence is well known to the enemy but whose details are kept secret to prevent their being copied. Examples are the French 75 gun and the Liberty Engine.

Occasionally two enemies in a war will both originate the same idea at about the same time. In our Civil War the Confederates originated the idea of the ironclad warships by covering the old steamer Merrimac with railroad iron. She steamed out of Norfolk and spread terror and havoc among the ships of the Union Fleet at Hampton Roads, but was

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prevented from completing the destruction of the fleet and proceeding to Washington with no one knows what consequences, by one most timely circumstance. This was the fact that the Union forces had also originated an ironclad, the MONITOR, which arrived on the scene just at this time and engaged the MERRIMAC in the first battle of ironclads.

In the Franco-Prussian War of 1870, the French had their great war secret, the Mitrailleuse, or first machine gun. Great things were expected from it, but the very secrecy with which it was guarded prevented the hoped-for success. It was kept so secret that the army did not learn its tactical use. These machine guns were mounted on wheels like pieces of artillery and, in consequence, they were used like field guns. They were not particularly well adapted for this use so that their effect was small. Moreover, the enemy seeing them used as a kind of artillery, brought up his field-gun batteries against the Mitrailleuse batteries and quickly destroyed them. If the guns had been in use by the whole army before their first employment in battle, no doubt the army would have learned their proper tactical use and they would have been employed as machine guns are today, with great success.

Fig. 2. Purposely Given a Misnomer, the Modified Rifle was Known as the "Pistol, Cal. .30, Mod. 1918."

WHILE almost every war has had its great secrets, the World War was probably most prolific of all on account of the large number of nations involved and the length of time the effort lasted. Among the World War secrets was the tank developed by the British. The attempt to conceal the existence of this armed juggernaut resulted in the name which has stuck to it ever since. Metal parts for this armored car were being made in various factories and one war official in an effort to hide the purpose of these constructions labeled some of the big sheet metal bodies "Tanks for Mesopotamia." In an entirely unexpected manner, the name "tank" stuck and now seems to be very descriptive.

Another World War secret that was not known to the general public until after the war was over, was the sky car that hung thousands of feet below the Zeppelins. When a Zeppelin was riding above the clouds, this car with an observer in it was lowered on a slender cable until the occupant could see the countryside below. By telephone communication he directed the dropping of bombs on cities and munitions works.

The depth-bomb was a war secret that accounted for a great many submarines and the paravane rendered the submarine mine comparatively harmless. This was a submerged torpedo-shaped metal tank with steering vanes on it, which was carried on board warships and transports during the latter part of the World War. When the ship approached the mine field, one of these paravanes attached by cable to the bow of the ship, was let down on each side. The motion of the ship combined with the steering surface vanes on the paravanes, caused them to ride in the water a hundred feet or more off to the side. The cable stretched from the paravane to the bow of the vessel would sweep up any submarine mines in its path by striking against the anchor rope of the mine, which would slide back along the cable toward the paravane, at the same time going farther and farther out from the side of the ship. Finally when the paravane was reached, the anchor cable slid into a heavy pair of corrugated jaws which cut the mine loose, allowing it to float free on the surface of the water where it could be destroyed by gun fire.

All these devices and others are now known to the public because they were used during the war and thus disclosed. However, one of our own greatest army secrets never was used because it was not ready for extensive use at the end of the war and for this reason has remained unknown to the present time.

This contrivance, called the Pedersen Device, was a new infantry weapon which was to have been sprung as a surprise on the Western Front in March, 1919. It consisted of a small attachment to the soldier's Springfield rifle which virtually converted the rifle into a miniature machine gun capable of delivering a whirlwind of rapid fire instead of intermittent shots.

THE rifle with which our infantry is armed is of the kind known as the bolt-action magazine rifle. The gun is loaded with a clip of five high powered cartridges which are fired one at a time while operating the mechanism of the rifle between each shot.

The breech of the rifle is closed by a bolt which operates very much like the old-fashioned sliding bolt of a door and by turning this handle upward the bolt can be drawn back, opening the breech of the rifle and throwing-out the fired cartridge. Then by pushing the bolt forward a new cartridge is driven into the chamber of the gun and the firing mechanism is cocked. On turning down the handle of the bolt it is locked securely in place so that it will hold the cartridge in the gun against the explosion which generates a pressure of 50,000 pounds to the square inch and drives the bullet out of the gun with a force sufficient to carry it three miles or to make it penetrate 60 inches of wood or one-half inch of iron.

The muzzle energy of the bullet fired by the ordinary military rifle is 2500 ft. lbs., which expressed in another way, means that the energy of the bullet when it leaves the gun is sufficient to lift over a ton of weight to a distance of a foot or to drive a one-pound weight 2500 feet straight up in the air. All this power is placed in the small bullet which is sent out to pierce the body of a man at battle ranges of 400 to 600 yards.

It will readily be seen that when the bullet merely strikes an enemy soldier it has far more power in it than is needed

to kill or wound the person struck. Moreover, the shock of firing this projectile with such enormous energy is sufficient to cause the gun to recoil or kick severely. Again the large quantity of powder used to drive the bullet out with this force produces a temperature of several thousand degrees in the rifle barrel and while this temperature does not last long, still it is sufficient to heat the barrel of the gun very

Fig. 3. The Pedersen Device.

Showing also the magazine and its bandolier, box of cartridges, and a single ball cartridge with the standard caliber .30 cartridge for comparison.

severely when a number of shots are fired in rapid succession.

It may seem at first glance that the military rifle cartridge is unduly powerful, but it must be remembered that this cartridge is intended to be used against various targets such as airplanes, armored cars, tanks, etc. Moreover, soldiers in combat are usually protected by more or less cover of different kinds, and some types of cover, such as trees, are capable of being readily penetrated by powerful bullets. Again, these same bullets are used by machine guns which need all the power they can get for laying out barrages at long distances or for shooting at high flying aircraft.

Thus a soldier in firing his army rifle is frequently in a situation where he has more power in his bullets than he needs for the particular job in hand; moreover, for each shot he must open the bolt of his gun and throw out the empty cartridge and then close the bolt and lock it before he can shoot another shot.

THIS was the situation in the summer of 1917 after the United States had entered the World War. At this time appeared Mr. J. D. Pedersen, who even then was a very well known rifle inventor, the successful designer of a number of sporting rifles and shotguns on the market from about 1910 to the present date.

Mr. Pedersen came to the War Department and informed the Chief of Ordnance that he had what he considered a very important invention which he wanted to have examined secretly. On account of Mr. Pedersen's prominence, this request was immediately granted and only one or two high officials in the War Department saw his device when it was demonstrated on the Congress Heights Rifle Range in the District of Columbia, just outside the city of Washington.

Mr. Pedersen started his demonstration by firing the Springfield rifle which he brought with him. After firing a few shots in the ordinary way he suddenly jerked the bolt out of the rifle and dropped it into a pouch which he had with him, and from a long scabbard which was on his belt he produced a mysterious looking piece of mechanism which he quickly slid into the rifle in place of the bolt, locking the device to the rifle by turning a catch provided for the purpose. Then he snapped into place a long black magazine containing forty small pistol size cartridges whose bullets were, however, of the right diameter to fit the barrel of the rifle. All this was done in an instant and in another instant Mr. Pedersen was pulling the trigger of the rifle time after time as fast as he could work his finger and each time he pulled the trigger the rifle fired a shot, threw out the empty cartridge and reloaded itself.

It was really a startling demonstration. In firing the Springfield rifle as rapidly as it can be done, the soldier pulls the trigger, turns up the bolt, jerks it back and shoves it forward, turns it down and then is ready to fire one more shot, but with this new device of Mr. Pedersen's all that was necessary was to keep pulling the trigger and the rifle did the rest. When the magazine of forty rounds was empty, it was the work of but a second to snap a new magazine into place and continue firing.

It looked as though he had converted the Springfield rifle into a one-man machine gun.

A further examination of the device showed that the cartridge he fired was only about one-fifth the size of the rifle cartridge, though the bullet was the same diameter. Coming now to ballistics, the new cartridge had an 80-grain bullet driven by 3½ grains of powder, whereas the old cartridge had a 150-grain bullet driven by 45 grains of powder. The old high-powered cartridge leaves the muzzle at a velocity of 2700 feet per second; the Pedersen cartridge leaves the muzzle at a velocity of 1300 feet per second.

As the energy of the bullet depends on the square of the velocity as well as on the bullet weight, it was found that the new bullet had a muzzle energy of about one-tenth that of the service cartridge. In other words, while the bullet of the service cartridge leaves the muzzle of the gun with an energy sufficient to lift a ton and a quarter a distance of a foot, the new bullet had only sufficient energy to lift one-eighth of a ton a foot. This is, however, quite sufficient to kill a man instantly at any range up to 500 yards, or say a little over one-quarter of a mile.

While the service bullet will penetrate 60 inches of wood a short distance away from the gun, the new bullet will penetrate only about eight inches or the same that the service rifle would penetrate one-half mile away.

However, a bullet which will penetrate eight or ten inches of wood will easily penetrate a man and it was apparent at once that this system which enabled a soldier to convert his rifle at a moment's notice into a low powered machine gun, was indeed a most important thing.

THE War Department officials who saw this test had visions of what might happen in case of an attack by the enemy on our trench system, should our men be armed with this device. As the enemy came charging across No Man's Land each of our soldiers would start firing with this miniature machine gun and the entire zone in front of the trenches would be covered with such a whirlwind of fire that no attack could survive—surprise of immense value.

Also it looked as though the device might have great possibilities for an attack starting from our own trenches. For one thing, there is no noticeable recoil from this Pedersen device and it could be fired from the hip while marching or running. A line of soldiers advancing across No Man's Land, firing this device at the enemy trenches as they ran, would make it extremely difficult for anyone in the trenches to show his head or any part of his body. Of course, fire while running or walking would not be so accurate, but the tremendous number of shots would more than make up for any inaccuracies and the whole enemy trench system would presumably be smothered with a storm of bullets.

The inventor had made this device readily interchangeable with the regular rifle bolt so that the bolt could be put back in the rifle at any time, thus enabling the rifle to be used with the high powered cartridge when this seemed desirable.

It was proposed that the soldier should go into battle carrying the usual high powered cartridges, and in addition, he would carry this device in a scabbard at his belt as well as a canvas pouch to carry the regular rifle bolt when the device was being used, and on his belt he would have a canvas case holding ten magazines of 40 rounds each for the device.

As the result of this demonstration the device appeared so important to the War Department officials that an officer of the Ordnance Department, Capt. J. C. Beatty, sworn to the greatest secrecy, was placed on a ship to take the device over to France and explain it in person to General Pershing.

This was in November, 1917, and on December 9, 1917, the device was tested at Langres, France, by a board consisting of:

Brig. Gen. James W. MacAndrew, N. A.; Col. J. H. Parker, Infantry, N. A.; Col. Leroy Eltinge, General Staff; Maj. A. E. Phillips, Ord. Dept., and Captain Beatty.

After repeated tests for penetration, accuracy, rapidity and endurance, the board found:

"1. That the attachment permits the service rifle to be changed from a high-powered, hand-operated rifle, to a semi-automatic rifle firing a smaller cartridge of the same caliber.

"2. That it permits the soldier to carry at least 400 rounds of ammunition, capable of being effective over the shorter ranges in addition to a regular supply of service cartridges to be used over the longer ranges.

"3. That the change from the service bolt to the attachment, or the reverse, can be made in about fifteen seconds, and in no way injures or incapacitates the rifle for the service cartridge or any of its other functions.

"4. That tactically the device is of special importance for the following purposes:

"(a) In an attack from trenches at ranges up to 350 yards, the attachment enables the assaulting troops to overwhelm the defensive with fire.

"(b) In the defense of trenches or of a position the attachment enables a preponderance of fire to be delivered at short ranges.

"(c) During an advance, when the artillery and machine gun barrage 'lifts,' the assaulting infantry can protect its immediate front by creating a so-called barrage of fire to the enemy trenches.

"(d) In the trenches it provides the soldier with a semi-automatic rifle and a magazine holding forty cartridges.

"(e) Just previous to and during the consolidation of the captured positions counter-attacks are to be guarded against; the supply of ammunition in the hands of troops is generally low and a replenishment usually impossible, owing to the enemy barrage; the automatic bolt and two hundred rounds of ammunition per man should be with the troops during this critical period.

"(f) The device will very greatly simplify the supply of ammunition.

"(g) Its greatest value will be in surprise effect.

Fig. 4. The Secret Device Inserted in the Rifle.

"5. The board therefore recommends that the Pedersen attachment for the rifle be adopted as soon as possible, and that an initial order for one hundred thousand (100,000) of these attachments be placed at once. The board also recommends that this device be kept as secret as is possible, and it not be issued for use until at least fifty thousand (50,000) are ready to be placed in the hands of troops. The board is of the opinion that the initial supply of ammunition should be about five thousand (5000) rounds per gun, with a daily supply of about one hundred (100) rounds per gun."

NEEDLESS to say, the order was placed at once and the secrecy which already surrounded the development was continued. As the name "Pedersen Device" seemed to be sufficiently mysterious to excite the curiosity of the people who must of necessity work on it in the various factories, a new name was adopted which was purposely made not at all descriptive of the device. This name was "Automatic Pistol, Caliber .30, Model 1918."

Of course the Pedersen device was in no sense a pistol and one of the amusing incidents connected with the matter is the fact that some officials who in some way heard this name, criticized the War Department severely for adopting a smaller caliber pistol or even for adopting a new pistol at all, as they contended our .45 automatic pistol was sufficiently good and if a new pistol were adopted it should be as big as the .45 instead of being reduced to .30.

The first order for 100,000 of the devices was given to the Remington Arms Company on March 26, 1918, and subsequently increased to 133,450. A break in the manufacture of rifles made certain increased manufacturing facilities available. The Pedersen device was first made to be used only on the Model 1903 rifle but in the meantime it had been further developed so that it would fit the Model 1917 rifle.

In view of these circumstances the question was now taken under consideration as to whether or not it would be advis-

able to give an additional order for 500,000 devices. This was considered to be advisable and a letter was written by the General Staff to General Pershing recommending it. Maj. Lee O. Wright of the Small Arms Division, Ordnance Department, carried the letter to France and delivered it in person. Favorable acceptance was given to this and at the end of September, 1918, the order for the Pedersen devices was increased to 500,000, the additional number being to fit the Model 1917 rifle. Eight hundred million rounds of ammunition were ordered and it was decided that the 500,000 devices could be ready to go on the front lines in the spring of 1919 and that they would be utilized in a surprise attack at that time.

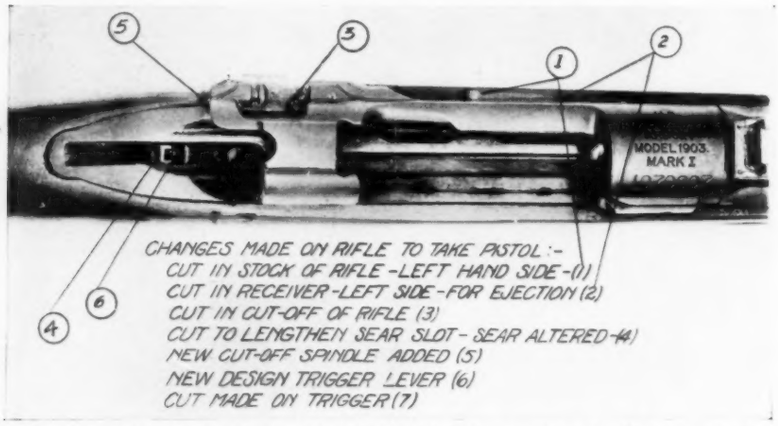


Fig. 5. The Springfield Rifle, Model 1903, Modified to Take the Pedersen Device.

It is an interesting speculation to think what would have occurred had our army started to cross No Man's Land some fine morning with half a million men, each armed with an individual machine gun and 400 rounds of ammunition.

However, the old weapons we already had at hand proved sufficiently good to get the Germans out of the trenches in October, 1918, and the war ended a month later with 65,000 of the Pedersen devices completed. The remaining orders were cancelled.

AFTER the Armistice the question arose as to what was to be the policy regarding this device in the future. To decide this question the device was given a thorough test in France by the Fiske Board consisting of:

Brig. Gens. Harold B. Fiske, Pres.; Alfred W. Bjornstad, Douglas MacArthur, Frank E. Bamford, Oliver Edwards, Cols. Walter C. Short, Albert E. Phillips, Earl McFarland, Lt. Cols. Joseph A. McAndrew, John J. Fulmer, H. M. Groninger, Major Wright, and the writer.

The secrecy was still continued and only General Pershing and certain members of his personal staff, together with the members of the board, knew about the test. In Washington permission was given to the Navy Department to have a representative present at this test and Commander G. L. Schuyler, who was stationed in London at that time, was ordered to attend the test in France. He took the matter up with the A. E. F. in France and was unable to obtain any information whatever of any such test. This was quite natural because as mentioned above, the test was not known to any of the people with whom he would come in contact in applying for information and he was quite honestly informed by the Army authorities in France that no such test was being made. This illustrates the excellent secrecy that was being maintained on the device at that time.

The Fiske Board conducted field firings with a platoon armed with the device firing against silhouette targets placed to represent the enemy and then repeated the test with the same platoon armed with the Springfield rifle without the device. These field firing tests were conducted on an isolated rifle range surrounded by forests not far from LeMans, France, in the spring of 1919, and the writer of this article was a member of the board that made the tests.

All of the firing was done by officers who were all sworn to secrecy until such time as the War Department might see fit to release the information.

In the fall of that same year, 1919, a further study of the Pedersen device was conducted in the United States by the Infantry and Cavalry Board which reported:

"That the soldier equipped as at present with none but necessary articles has all the burden he can reasonably be expected to carry on marches. These articles include 92 rounds of rifle ammunition, caliber .30, weighing approximately 4½ pounds and no less supply of this heavy ammunition should be in his possession at all times. Ammunition of this type is capable of effective use under all conditions of fire at all combat distances. Experience has shown that on the offensive the usual combat distances are between 400 and 600 yards.

"The value of the Pedersen device rests in the fact that a very effective volume of sustained fire may be delivered with it. To secure this volume of sustained fire not less than 400 cartridges should be at hand, and these in magazines and carriers weigh about 11½ pounds, so that the soldier to have the device and cartridges at hand when needed would be obliged to carry at all times 13¾ pounds in addition to his already heavy burden. The weight of these 400 rounds is equal to four bandoleers of rifle ammunition.

"The effective range of the fire delivered by the device is only 350 yards. On the offensive it would be necessary to advance up to that distance by means of the ordinary rifle before changing. At this distance the fire of the enemy may be reasonably assumed to be as intense and effective. Under such fire the bolt of the rifle would have to be removed and put in some secure place, the device inserted and adjusted, and the magazine attached, before fire could be opened, and the fire superiority already gained with the rifle would be lost in the moments required.

"So long as the magazine of the device remains attached to the rifle, its efficiency in bayonet combat is reduced.

"The board thinks that the device has no valuable qualities for stabilized defensive warfare."

In 1920 the Infantry Board at Fort Benning tested this device and the Cavalry Board at Fort Riley also made a test at the same time.

Thus an intensive study of the possibilities of this weapon for future use was made by four boards. These studies revealed clearly that the device has its greatest usefulness in a situation such as that in the World War where the contestants have reached stabilized positions in trenches, and that for almost any other kind of campaign it had disadvan-

tages which would probably prevent its use. For example, the average battle range is from 400 to 600 yards and owing to the low power of the bullet from the Pedersen device, it is accurate only up to about 350 yards and beyond that it is difficult to hit anything with it.

Owing to its low velocity it has a high trajectory. If it were sighted to hit a man at 500 yards, a man at 300 yards would be safe because the bullet would pass over his head.

THEN again, a more serious objection is that at the present time the infantry soldier has practically everything he can possibly carry loaded on him and his rifle, bayonet, ammunition and equipment pack, are all things which cannot be discarded or reduced in any way. To make him carry in addition a metal scabbard with the Pedersen device, a canvas pouch with bolt of his rifle, and ten magazines full of Pedersen ammunition, would be practically impossible in any campaign of movement.

Greater experience shows that if the soldiers were called on to advance a certain distance using their Springfield rifles with the regular ammunition at long ranges and then at some point in their advance they had to change to the Pedersen device, they would usually reach their objective without the regular rifle bolt, as this would be lost, dropped or thrown away in their excitement.

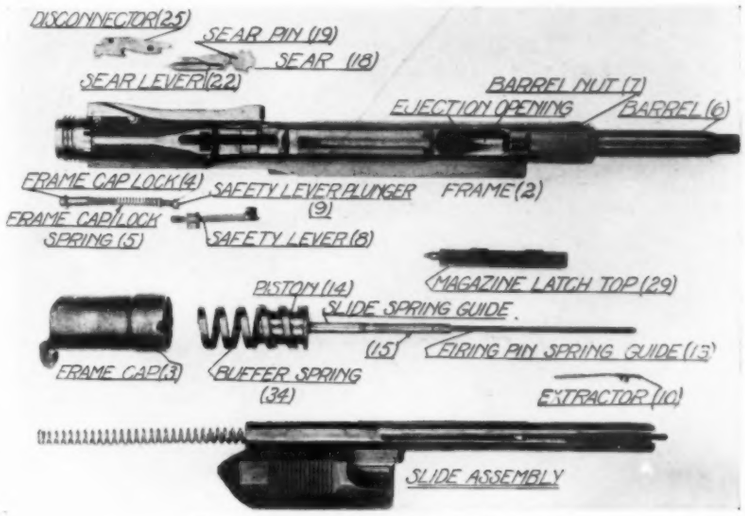


Fig. 6. Parts of the Pedersen Device.

One way in which the Pedersen device differs from the Springfield rifle is in its comparative silence. When the rifle is fired it makes a very loud noise, and moreover, the bullet itself creates an air wave which causes a vicious *crack!* whenever the bullet passes a man or an object.

Any bullet or projectile which travels at a speed higher than the velocity of sound creates this air wave and makes this sharp, menacing noise when it passes. In the Pedersen device the powder charge is small in relation to the barrel so that the firing of the gun itself makes little noise and the bullet itself does not produce the air wave that causes the bullet to "bark" when it passes.

In one of our peace-time tests, a number of colored soldiers in a pit were operating some targets which were being shot by both the service rifle and the Pedersen device. While the firing was going on with the high powered cartridges, the soldiers kept down as low as possible, entirely over-awed by the vicious and menacing snap of the service bullets as they passed. When the shift was made to the Pedersen device, holes began coming into the target faster than ever but without the noise, and the soldiers all got up as high as possible and wanted to look over the edge or go outside the trenches to see what was going on.

As a result it was thought by some of the observers that the lack of moral effect on account of its silence, was a serious disadvantage of this weapon. Some other observers of this incident thought that this lack of noise pointed to an advantage for the Pedersen device; the enemy would be bolder about leaving their cover and would become easier targets. However, this opinion was decidedly in the minority. Most of the observers thought that the menacing noise of the Springfield rifle bullet is a decided asset owing to the moral effect it has in instilling fear into the enemy and that any weapon which lacks this noise would place its users at a disadvantage.

Another factor having a heavy bearing on the usefulness of the Pedersen device in any future conflict is the increased importance of the ability of ground troops to protect themselves from "strafing" by fast, low-flying aircraft.

Imagine a column of troops on the march, or a wagon train on the road. Suddenly an airplane, or a dozen of them, flash into view ahead, only fifty or a hundred feet off the ground, and roar down the column at perhaps 200 miles per hour, each plane firing four machine guns and dropping a dozen or more small but deadly fragmentation bombs. From the time they are first seen just over the horizon 500 yards ahead until they pass behind the hill 500 yards to the rear is but ten seconds—scant time to get the ground machine guns into action; and little chance to maneuver them quickly enough for their aim to follow the streaking planes. But there are a thousand men in a battalion and if each man shoots at the coming planes just as a hunter shoots at a duck, the sky will be full of bullets and "strafing" ground troops will soon become known as a dangerous occupation for aviators.

BUT the bullet of the Pedersen device is not powerful enough to seriously damage a plane; moreover, it is comparatively so slow that it would be necessary to aim quite a distance in front of the plane in order to hit. Thus it is not the weapon for this increasingly important use. The Springfield rifle with full powered cartridges is better. The heavy bullet will reach out to 500 yards or more with ample power to penetrate the engine or any part of the plane that may be struck. There is just one trouble; the soldier can get off only about two shots with the hand-operated rifle while the plane is within gunshot.

What is obviously needed is a full powered rifle that works automatically like the Pedersen device, reloading by its own power so that the soldier does not have to work the bolt by hand. This has been the goal of inventors for the last twenty-five years, and numerous hunting rifles of medium power working on this principle have been produced, but up to the end of the World War no satisfactory military

rifle of this kind had been submitted to our Army authorities. The models were too heavy, too clumsy or too complicated.

However, after the World War this problem was attacked with renewed vigor, and there are now at least two types of full powered military self-loading rifles which have proven successful in tests. These guns hold ten shots at each loading, instead of five as does the Springfield, and as there is nothing required to shoot them except to keep aiming and pulling the trigger, all ten shots can be fired with ease during the time an airplane is in range.

During the twelve years that the Pedersen devices have been kept in storage, these and other reasons have made it increasingly evident that its main usefulness would be in a stabilized type of trench warfare, which will probably never occur again, and it has therefore been decided that it is no longer desirable to keep their existence secret. At the present time they are not considered an important arm.

WHILE the history of the Pedersen device has been given very briefly above, we have not yet described the device itself very clearly and for those who are interested a short description follows.

The Pedersen device (Fig. 3) is what is known as an automatic bolt for the Springfield rifle and is very much the same thing as a straight "blow-back" type automatic pistol without any stock, the dimensions of what would otherwise be a pistol being changed sufficiently to adapt it to fit in the rifle in place of the bolt. The barrel of the pistol was just the same size, shape and length as the regular Springfield rifle cartridge (without the bullet).

The device was adapted to be locked in place in the receiver of the regular magazine cut-off of the Springfield rifle. On the upper right-hand part of the device in the front of the receiver opening in the rifle was a spring catch to hold the long magazine, which when placed in position slants upward and to the right at an angle of about 45°.

The ejection of the fired cartridge case is through a port on the left-hand side of the device and a corresponding port must be cut in the receiver of the rifle, as can be seen in Fig. 4.

It will thus be seen that a special modified Springfield rifle is required. Not only does the rifle have to have the ejection port in the receiver, but it must have two grooves in the magazine cut-off and a little kicker in the sear.

The actual release of the firing mechanism is accomplished by pushing forward on a little projection on the bottom. A pivoted lever in the sear of the rifle fits in the notch shown in the bottom of the device (Fig. 3), and gives the necessary forward impulse when the trigger of the rifle is pulled.

The Springfield rifle as thus modified, is called the Mark I. These modifications do not injure the rifle in any way for regular shooting with the full-powered cartridge and the Mark I rifle is just as good for all other purposes as any other rifle. Needless to say, the Government manufactured one Mark I rifle for each Pedersen device which was produced.

Figure 3 also shows the small cartridge compared with the regular service cartridge; the 40-round magazine and the magazine bandoleer holding five loaded magazines of 200 shots.

Looking at the picture of the device, it will be seen that there is a little lump or weight on the top. Every time the gun is fired this lump weight, which is part of the breech block, slides to the rear and then jumps forward again, something like a mouse running backward and forward on top of the receiver. It is the inertia of this weight which enables the very high velocity of 1300 foot seconds to be obtained as against 800 or 900 foot seconds of the ordinary automatic pistol of the same size.

The whole device in its metal scabbard weighs 2 pounds and 2 ounces and the loaded magazine filled with 40 rounds weighs one pound.

As mentioned in the earlier part of this article, the Pedersen cartridge had a powder charge of 3.2 grains of bull's-eye powder giving a velocity of 1300 foot seconds. After the Armistice a study was made to determine whether the power of this cartridge could be increased. The original length of the cartridge case was .78-inch and the case was lengthened to .93-inch and loaded with an increased powder charge in an attempt to get a higher velocity. A charge of 4.7 bull's-eye gave 1500 foot seconds.

One of the disadvantages of the device in its original condition was the rather hard trigger pull which was about 22 pounds. In the attempt to improve this device after the war, the trigger pull was reduced to 10½ to 12½ pounds in six sample devices at Springfield Armory.

However, these attempts at improvement were abandoned when it was found that the trend of thought was that the device would not find an important use in future warfare.

For those who are interested in further mechanical details of the Pedersen device, several additional illustrations are included showing both assembled and disassembled views.

A Review of Poland's Mechanized Equipment, Pilsudski Square, Warsaw, May, 1932.

Building a Great Weapon in Record Time

The Largest All-Welded Gun Carriage Ever Fabricated

By John W. Slattery*

THE new 155-mm. gun--8-inch howitzer carriage, T2, is a notable instance of the application of welding to manufacture. The carriage was completed in the artillery vehicle shops of Rock Island Arsenal, in a total elapsed time period of 87 working days. This matériel is the largest all-welded gun carriage ever fabricated.

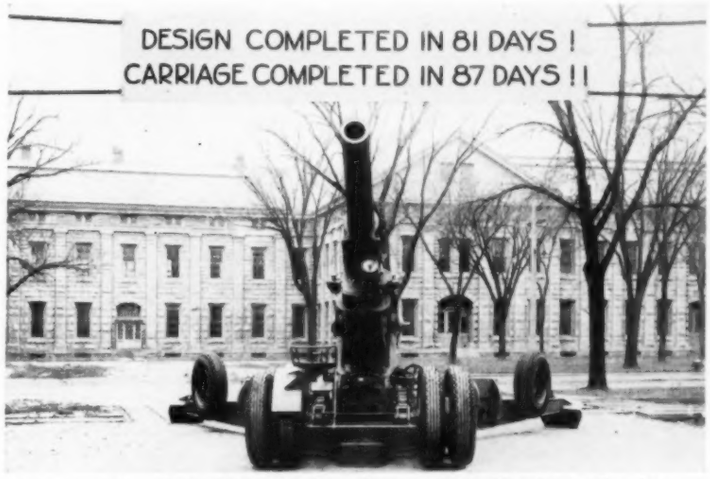


Fig. 1. The All-Welded 155-mm. Gun—8-inch Howitzer Carriage.

In the Fiftieth Anniversary Issue, dated April, 1930, of *Mechanical Engineering*, a monthly journal published by The American Society of Mechanical Engineers, a staff contribution prepared from information furnished by Mr. Charles H. Huston and others, on "The Iron and Steel Industry," reads: "The very extensive use of gas cutting and of gas and electric welding simplifies the delivery of many kinds of steel in proper shape for further fabrication. Large beams, heavy plates and heavy bars can be cut to size either directly from the rolls or from stock with greater speed and convenience than was possible by former methods. Gas and electric welding have been adapted to the mass manufacture of heavy structures for oil-cracking stills, pipe lines, steel buildings, bridges, ... and other uses."

As this type of gun carriage construction has some unusual features, which should prove of special interest to those interested in the extension of welding to the manufacture of artillery carriages, this article is written to describe some aspects of its manufacture. It points the way towards the manufacture in a comparatively brief space of time, of gun carriages during an emergency.

ON August 13, 1930, the Chief of Ordnance issued instructions to the Commanding Officer, Rock Island Arsenal, authorizing the completion of the design and the manufacture of one 155-mm. gun—8-inch howitzer carriage, T2. These instructions were received at the Arsenal on August 16, 1930; and the design proper was begun in the Arsenal drafting room two days later. The completion of this design was under the direction of Mr. T. A. Conlon, of the Office of the Chief of Ordnance, who was assisted by the drafting room forces of the Arsenal. The design was completed in 81 working days (Fig. 1). Upon the completion of the drawings, they were placed in the artillery vehicle shops, and manufacture of the carriage was started.

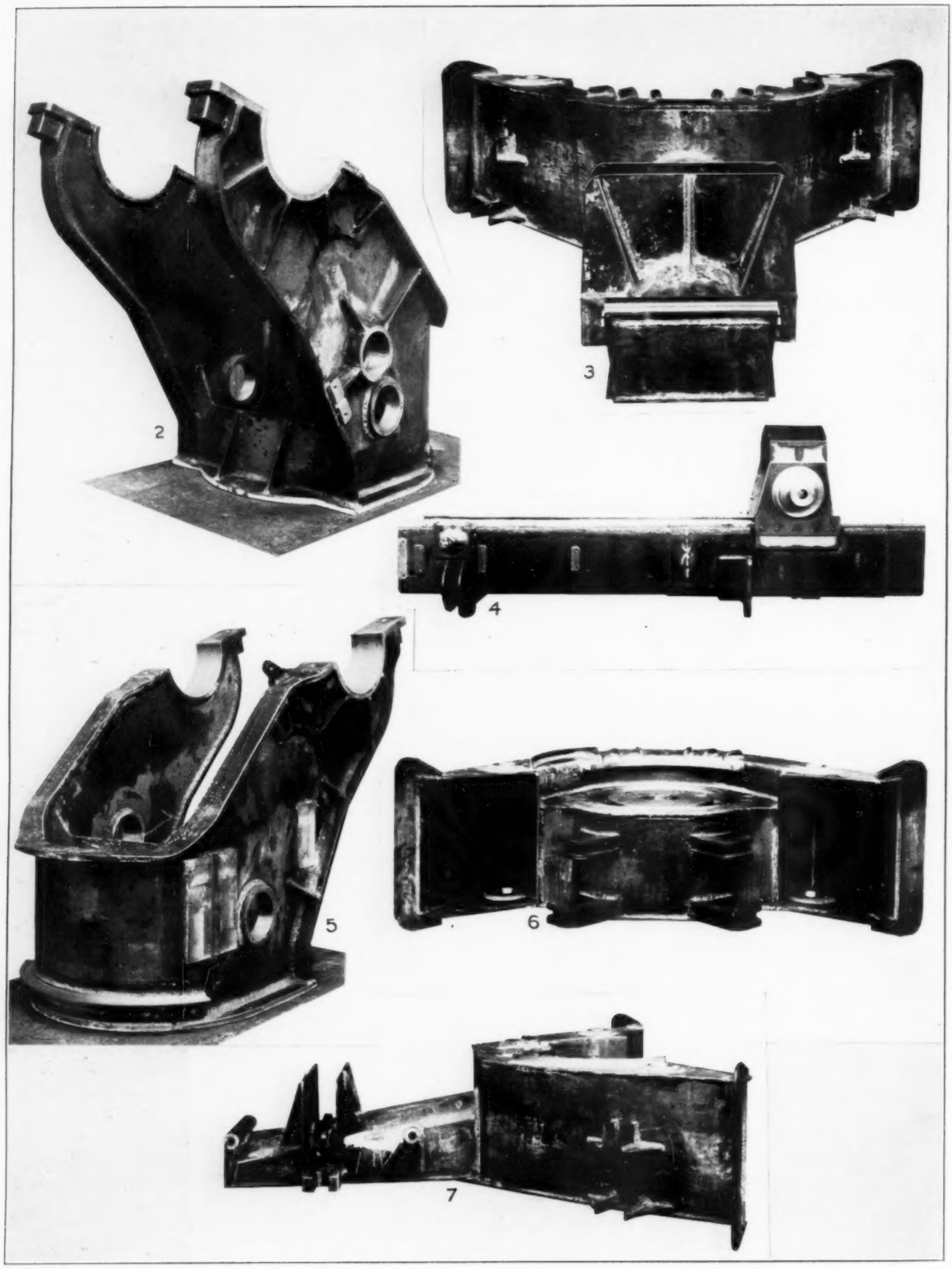
First a manufacturing program was prepared, based upon a production period of 90 days. The purchase of the various steels entering into the manufacture of this carriage was let out on circular proposals under carefully scrutinized delivery dates. In the preparation of the job orders, the writers were held to the utmost simplification of processes. That the carriage was actually completed during an elapsed time of 87 working days, which period represents the complete time interval of its manufacture, is mainly due to the completeness of this production plan, and its aggressive follow-up.

The early completion is also attributable to the fact that Rock Island Arsenal is fortunate in having in its employ many long-time and experienced employees. The singular unity, skill and success which has always characterized these employees and the men under them as a working group, is too well known to require further comment.

Manufacture of the 155-mm. gun—8-inch howitzer carriage, T2, at the Rock Island Arsenal was first initiated on the top carriage (Fig. 2), which consists of approximately 45 different pieces of structural nickel-steel plate cut to the desired shape on an automatic shape-cutting machine and welded together in their various juxtapositions of reinforcement to make a rigid component. The main body (Fig. 5), which is fabricated from a piece of structural nickel steel plate ½-inch thick, 46 x 114 inches, was first cut out to the developed shape, and was then partially bent by rolling in a large circular rolling machine. It was then bent to the desired form by a method improvised at Rock Island Arsenal in a 1200-ton hydraulic press, without special tools. The holes for the bearing bushings for the elevating mechanism were then located and cut to size with the automatic shape-cutting machine; the bottom plate and the various ribs, braces and reinforcements entering into this component had been previously cut to shape. Those items requiring bending or forming were shaped with angle-bending dies, which are part of the regular equipment of the hydraulic press department of the Arsenal. The main section of the top carriage was then tack welded to the bottom plate in its proper location, and the ribs around the outer contour tacked in place on the body.

The body section was now welded securely to the bottom plate, after which the two cross webs in the interior were located and welded in place. The bearings were then tacked

*Assistant to the Chief of Manufacture, Rock Island Arsenal. Captain, Ordnance Department, U. S. Army.



Welded Units of the Gun-Howitzer Carriage.

Fig. 2. Top carriage assembly of interior ribs and vertical formed reinforce, bearings, ribs and pads; Fig. 3. Bottom carriage, front view; Fig. 4. Finished cradle; Fig. 5. Top carriage assembly; Fig. 6. Bottom carriage, rear view; Fig. 7. Bottom carriage, side view.

in place, all ribs fitted in their proper location and securely tacked, after which all joints of the top carriage were fillet welded. Before annealing the finished unit, a tie bar approximately 1 x 4 inches in section was welded between the trunnion supports, to act as an eliminator for any distortion which might be set up at that important point. After annealing to eliminate welding stresses, this tie bar was cut out. No distortion due to the relief of welding strains was present.

The bottom carriage (Fig. 3) is constructed principally of ⅜-inch nickel steel plate, consisting of approximately 85 pieces. These plates were all cut with the automatic shape-cutting machine and straightened, where necessary, before entering into the assembly. The two main vertical members (Fig. 3) and the arched tapered projections (Fig. 6) attached at the forward end, were formed in improvised dies in the 1200-ton hydraulic press. Each member was accurately located in the assembly by a careful layout as the assembly progressed. It was necessary to omit the bottom plate until all the interior welding had been completed, after which it was securely welded around the entire perimeter. The bottom carriage was then taken to Shop M, where the remaining machining required was performed.

The bearing surface which secures the top carriage was machined in a 10-ft. boring mill, which was taxed to its utmost capacity in handling this job. In fact a 1/64-inch clearance was all that could be obtained. The bearings for the trail pins were machined on a large horizontal boring machine. The mounting of the bottom carriage brass liner presented no difficulty in its emplacement.

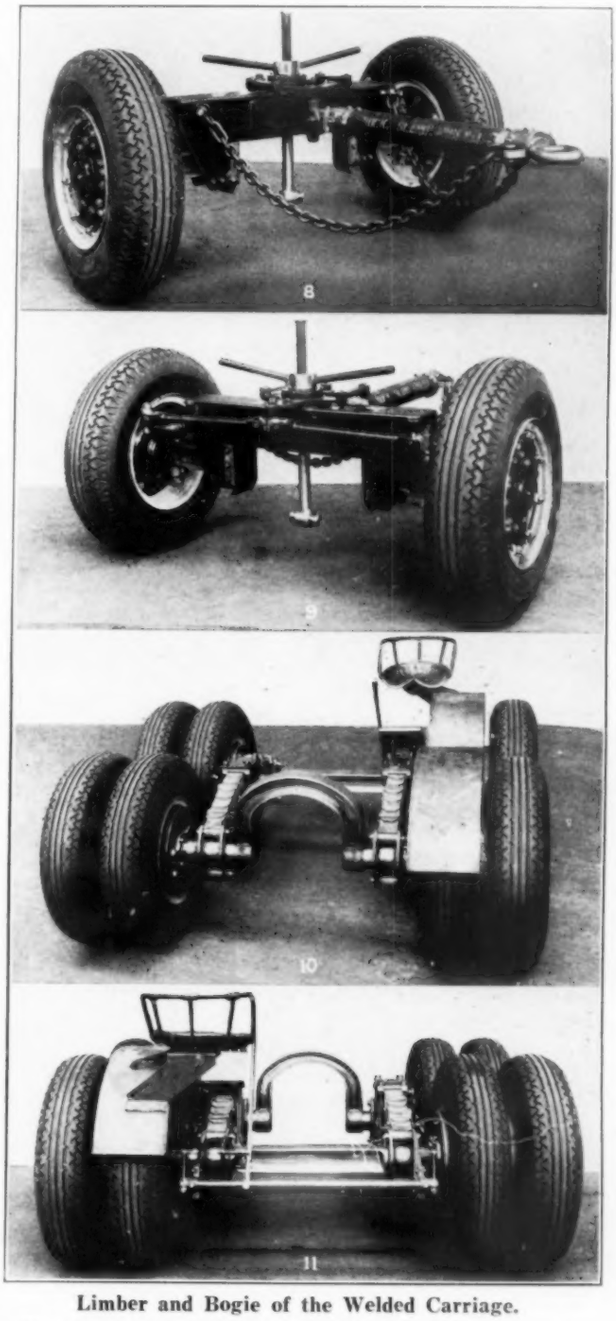
The only difficulty encountered in fabrication of the top carriage was the tendency of the entire forward end to shrink due to shrinkage of the welded joints around the inner edges. This was readily overcome, however, by making provision for this shrinkage by measuring the center distance between trail pin bearings and making allowance for such shrinkage.

THE cradle (Fig. 4), the main cradle trough and the reinforce around it at the trunnions were constructed of ¼-inch nickel steel plate formed in improvised angle dies and squared-up by hand. The welding slots in the reinforce were located and burned out with a hand cutting torch, after which they were securely clamped to the trough and welded in place. The top edges of this assembly were planed to the required height and the gun slides, which are a single unit planed from a rectangular billet, were placed in position and welded to the trough. The various parts, brackets and reinforcements were then welded in place, after which the gun slides were finish planed. The trunnions and equilibrator arms were then spotted and doweled in place. The arched tie was placed between the trunnions and finish welded. The principal difficulty in the assembly of this unit is the tendency for the closing-in of the trough at the points where welding is done on the outside surface. This is unavoidable, and provisions were made to allow a sufficient clearance in the interior for the assembly of the recoil mechanism.

The trunnions were turned and bored on a horizontal boring machine.

In the construction of the limber (Fig. 8), the axle was drop forged from a billet of high grade nickel steel (W. D. 2340), normalized at 1700° F., and annealed at 1400°. The machining to dimensions presented no difficulties in manufacture. The spindles (Fig. 9) were hand forged, normalized and heat treated. All component parts were also normalized and heat treated.

The hubs on the bogie (Fig. 10) were forged and heat treated before being machined. The two axles (Fig. 11) and the cross beam and all nuts, bolts, keys, yokes, rods, etc., entering into the construction of this bogie were hand forged, normalized and heat treated.



Limber and Bogie of the Welded Carriage.

Fig. 8. Limber, front view; Fig. 9. Limber, rear view; Fig. 10. Bogie, front view; Fig. 11. Bogie, rear view.

As Rock Island Arsenal did not possess annealing furnaces of sufficient size to handle the top carriage, this item was taken to the steel foundry of the Zimmerman Steel Company of Bettendorf, Iowa (a distance of about five miles from the Arsenal), and placed in their large annealing

furnace, to relieve all welding stresses. The top carriage was first heated to 1100° F. for about six hours, and then allowed to cool slowly in the furnace over night. The bottom carriage was subjected to the same heat treatment. Both items were found to pass the subsequent inspection.

The recoil, counter-recoil and recuperator cylinders and all piston rods entering into the assembly of the recoil mechanism were drilled, hognosed and woodpacked-reamed from a high grade of nickel steel, quenched and drawn. The cylinders were finish-lapped to obtain the desired accuracy of finish. The final assembly of the completed unit into the rear yoke and front transom was accomplished without difficulty, as was the final fitting into the welded cradle. The counter-recoil and the recuperator cylinders were connected by a specially designed communication port. The replenisher for the recoil cylinder represents a departure in the recoil mechanism design. It is assembled directly to the control rod, instead of to the side of the mechanism as heretofore.

THE simplification of welded construction has been employed to advantage in the fabrication of the trails. Each trail consists principally of four plates of structural nickel steel which were sheared to size in a large power shear, after which the side and top members were formed in a large hydraulic press, without special tools. The holes in the top and bottom plates which received the bushings were accurately located and cut on the automatic shape-cutting machine. The bushings were then arc welded in these holes. The holes for the bushings in the trail hinge plates were then finish bored and faced. The vertical members were then tack welded in their proper position on the bottom plate, and the transoms and trail connections welded in their position on the inside. The top plate was then placed in position and tack welded, after which the bottom and top plates were finish welded to the side plates. This last welding operation required great care, as it was necessary to eliminate the effect of strains which have a tendency to twist the entire assembly. The holes in the bushings for the trail hinge pins were then finished bored and faced. This welding was accomplished without difficulty, and it was not necessary to do any straightening of these members whatsoever after welding. The various parts, brackets and ribs were located in position and arc welded in place.

The carriage was subjected to a road test of 224 miles over gently rolling country roads in the vicinity of Rock Island Arsenal. The carriage tracks the towing vehicle perfectly, and it holds the paved and improved country roads without difficulty. It maneuvered easily into firing position.

Later the carriage was successfully proof fired at the Savanna Ordnance Depot. Fifteen rounds, up to and including 110 per cent charge, were fired into the butt at 0° elevation to test the action of recoil and counter-recoil mechanisms and the general behavior of the carriage at this elevation.

On its return to the Arsenal, the carriage was entirely disassembled and thoroughly inspected by the inspection forces. No rupture of the welded joints could be found. The welding employed in this construction proved entirely satisfactory, showed no seams on the vehicle at the welded joints, and all other components were in good condition.

THE experience of Rock Island Arsenal in the fabrication of the 155-mm. gun—8-inch howitzer carriage indicates that the adoption of electric welding saves time, labor and material.

This carriage appears to be an ideal one to accompany a field army, as set forth in the requirements of the Caliber Board; and is thought to be a decided step forward as regards design and manufacture of artillery vehicles. In an editorial comment preceding an article written by Brig. Gen. W. I. Westervelt, entitled "A Challenge to American Engineers," published in the September-October, 1920, issue of Army Ordnance, the editor at that time, Col. James L. Walsh, wrote, in part:

"The report of the Westervelt Board is no more and no less than a call to arms of every engineer in the United States, both in the service and out—a challenge to design, develop and produce new and heretofore almost entirely unconsidered types of war matériel for the ultimate purpose of preventing wastage of human life in defense of our country. It should appeal to the heart and brain of every American engineer qualified in any way to accept the challenge."

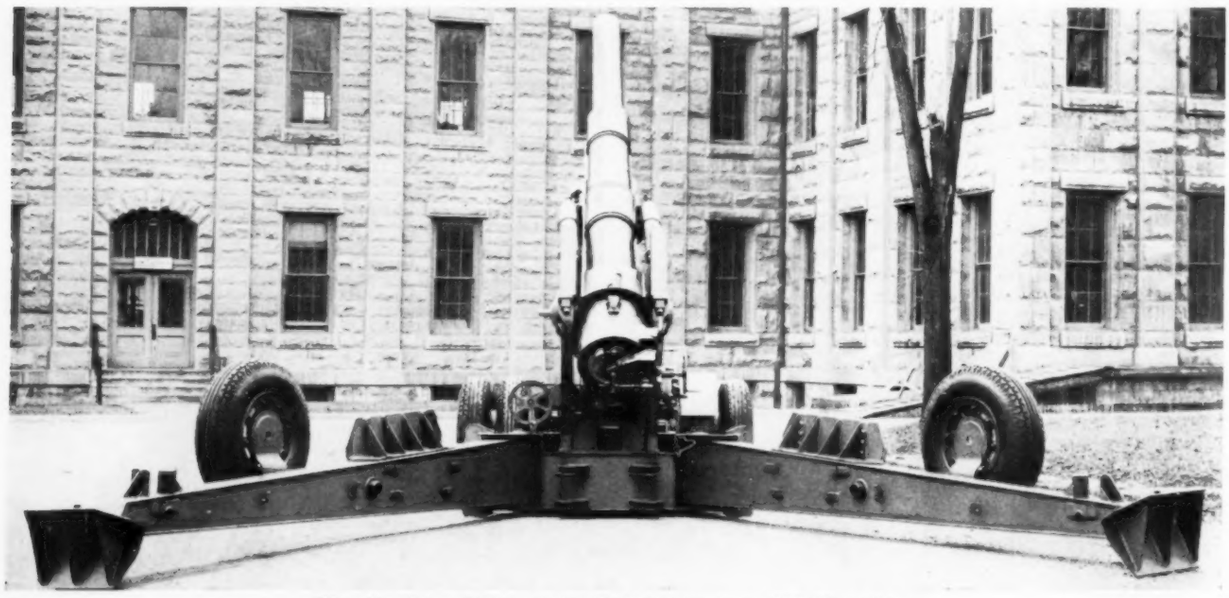


Fig. 12. Rear View of the Welded Carriage, 45° Elevation.

Styles In Small Arms Projectiles

An Analysis of the Development of Bullet Shapes - Old and New

By Thomas H. Green*

IN the course of a recent study of one phase of small arms projectiles, considerable historical data were obtained from various sources. Because of its possible interest to readers of this Journal and with a view to assisting future investigators of the same or a kindred subject, I have been invited to compile and publish a portion of the information thus obtained. The purpose of this paper, therefore, is to set forth a brief history of the development of certain phases of projectiles.

Since ballistic efficiency for several centuries has been one of the major aims of the armies of the world, the subject of projectiles has received a great deal of scientific consideration which is evidenced by the many volumes which have been written on the subject. Projectile-making is one of the oldest known arts. By persistent study, extending over centuries, it has developed to the point where even the minor scientific aspects bewilder the layman.

The earliest form of projectile used in connection with a gun appears to have been spherical. The theory existing at the time was that a spherical projectile would give more accuracy. The ballisticians of this age relied upon mass to obtain shock and therefore believed that the larger the projectile the more satisfactory the weapon. The round projectile remained the ideal form for a long period and efforts to increase accuracy were confined to perfection in workmanship and the attainment of a balance between the weight of the bullet and the volume of the powder charge.

The state of the art at the beginning of the 18th century is shown by British Patent No. 418, issued to James Puckle under date of May 15, 1718. This patent had for its motto "A Defense—defending King George, your Country and the Lawes is defending Yourself and the Protestant Cause." In applying for his patent Mr. Puckle provided a form of Gatling gun having two interchangeable chambers. One of these chambers was provided with round holes and the other with square holes. The avowed object of Mr. Puckle was, as is stated in the patent, to enable the shooting of square bullets against Turks and round bullets against Christians.

FROM about the year 1400 to 1800 the military bullets of all nations were for the most part spherical and although made by hand they were remarkably accurate. The preferred caliber of the bullets in use at this stage seems to have been about 18 mm. which was a sizeable projectile for small arms. During this period there were a number of experimenters who sought to improve the existing form of projectile. Among these were Sir Isaac Newton, d'Alembert and Lacroix. In 1740, 1744, and 1814 respectively these investigators decided that mathematically the most advantageous shape for an improved projectile was an "ovoid" with an inflated rear portion. As used by these investigators the term "ovoid" meant a pointed bullet of small ogive. The term "ogive" seems to have been used first to designate the two arcs of a Gothic arch. At present it is rather universally intended to mean the curve of the form of the projectile expressed in calibers or some other equally satisfactory unit.

The first in the field actively to consider the best form of projectile for modern firearms was Capt. G. Piobert, a French Artillery officer, who about 1835 conducted experiments for the purpose of determining the form of projectile which offered the least resistance to the air. In 1841 this experimenter in a series of lectures at the School of Application of Artillery and Engineers in France stated that the best form of projectile was one which presented the least resistance to the air and from his experiments he had found that the length of such projectile should be five times its maximum width and that the widest section should be situated two-fifths of the distance from the front. The diagram accompanying the Piobert disclosure showed a projectile having a rounded head portion and a rear portion tapering to a point.

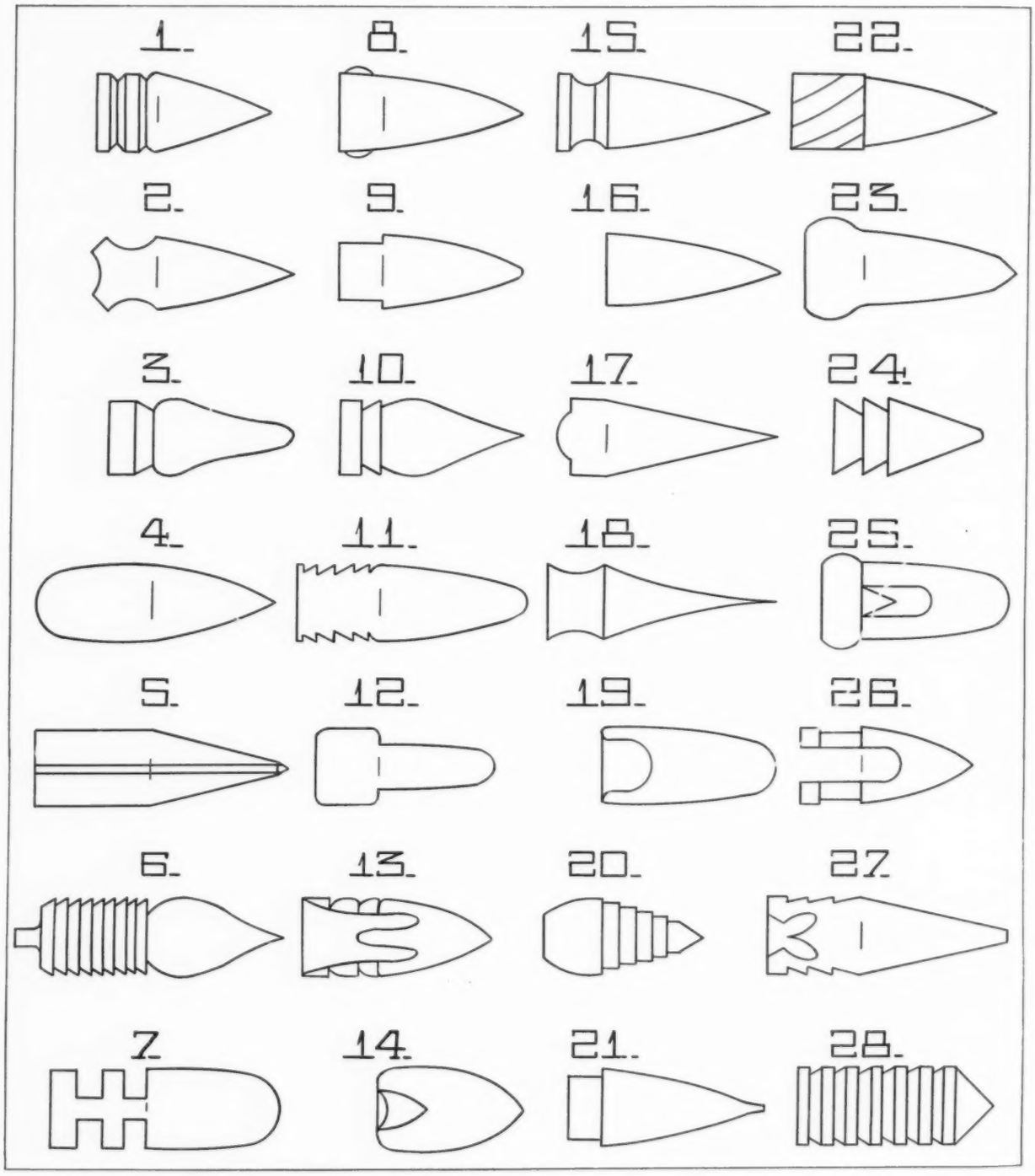
The report of the lectures of Captain Piobert with reference to this subject is to be found in "Cours d'Artillerie" published in France in 1841. Numerous text writers on the question of exterior ballistics have begun their consideration of the subject with an explanation of the work of Captain Piobert. A curious error has crept into practically every one of these publications, which error seems to have had more than a slight effect upon the experimenters following Piobert. In his original disclosure Captain Piobert stated *"on a trouvé que sa longueur devait etre 5 fois sa plus grande largeur et, que la plus grande section était situeé aux 2/5 de la partie antérieure."* Translators of the quotation invariably referred to the word anterior as the rear portion. Actually, it is the forward or head portion. Experimenters subsequent to Piobert, however, in accordance with the translations reversed the Piobert bullet and actually fired it point foremost. Examples are found in the following publications:

"A Treatise on Ordnance and Armor" by A. L. Holley (London, 1865), at page 536, states: "Piobert says that the form, Fig. 309, will experience the least resistance from the air. Its length is five times its greatest diameter, and its largest section is placed at 2/5 of the length from the hind part. The shape of some of Mr. Whitworth's projectiles approach more nearly to this form than those of any elongated projectiles hitherto used."

"Principles of Gunnery, Rifled Ordnance," by Major J. Sladen, R.A. (London, 1879), states on page 44 with reference to the Piobert projectile "Its length is five times its greatest diameter, and its largest section is placed at 2/5 of its length from the base." This quotation cites as authority Owen's "Modern Artillery."

Publications in practically every language disclosed the experiments of Captain Piobert and although there were prior experiments of note it is generally conceded that the contribution to the art by Piobert was one of the greatest steps forward in the endless development to obtain the most efficient form of projectile. From the time of Piobert intensive study has been given to the form of projectiles and the strides have been very rapid up to the present day. The greatest periods of development seem to have been before

*Captain, Judge Advocate General's Department, U. S. Army.



Small Arms Projectile Designs Prior to the American Civil War.

1. Prussian; 2. Swiss; 3. Russian; 4. Prussian; 5. Arrow Ball; 6. Spanish; 7. Hunting; 8. Russian; 9. Colts; 10 Russian; 11. Mangeot; 12. Richards; 13. Peters; 14. Beckwith; 15. Russian; 16. American; 17. English; 18. Sardinia; 19. Enfield; 20. Pomme a Pin; 21. Mexican; 22. Whitworth; 23. Swiss; 24. Prussian; 25. Beckwith; 26. French; 27. Mangeot; 28. Tamisier.

and during wars between major powers. Development appears to run in cycles and seems to be based upon the competition which has been in existence since the beginning of time. Immediately a new principle is discovered the ballisticians of the world seize upon it and apply it to maximum advantage.

IN 1907 Lieutenant Colonel Pratt of the French Army published a booklet on the subject of the "Balle D" bullet. This publication was a very limited edition and with the exception of private copies can be found only in the Bibliotique Nationale of Paris, France. The following quotation with reference to the early European history of bullets is considered worthy of quotation at length: "In 1812, a gunsmith, Pauly, tried a quite remarkable elongated projectile, with his extraordinary rifle, which should be considered as the prototype of the Dreyse needle-rifle, and of the present perfected arms. Everything was there: the loading by the breech, a very satisfactory block system of locking, inclined grooves, cartridges with priming at the base by a grain of chloride of potassium exploded by a hammer, cylindro-conical bullets of a 16-mm. caliber. This rifle, presented to the Minister of War, was the subject of a favorable report by General Allix, and was examined in January, 1813, by Napoleon I. Its rapidity of firing was 6 shots a minute and its reach was more than double. Unfortunately the great worries of the 1813 and 1814 campaigns made him lose sight of the question.

"This gun had such a superiority over all contemporary arms that one may logically think that with the tactical utilizations to which Napoleon the First would have put it, France would not have known defeat.

"In 1830, Captain Delvigne put in practice, for arms loaded by the muzzle, a cylindro-conical bullet weighing 25 grammes and of a 15-mm. caliber, by building his grooved rifle. The forcing-in of the bullet, grounded on the salient top of a powder chamber narrower than the bore, was done by pushing it with a ramrod.

"Experiments were successful, which did not prevent the military boards from systematically turning down this model for 15 years. One of them even went as far as to state that this rifle was absurd and inadmissible. Offended but not discouraged, Captain Delvigne resigned from the army in order to discuss more freely with his former chiefs. However it was only in 1844 that the Academy of Sciences, through the medium of the great Arago, rendered him, in a striking manner, the justice he was entitled to.

"Captain Tamisier, inspiring himself from the Delvigne bullet, created in 1846 a 17-mm. oblong and cannelured bullet; then Captain Minie, in 1849, created a 14-mm. oblong bullet with a cavity at the base.

"During that time, in 1841, the German gunsmith Dreyse had had Prussia adopt his needle-gun with ovoid bullets weighing 31 grammes and of a 14-mm. caliber.

"Dreyse had been employed by Pauly in Paris from 1808 to 1814, and had worked on the amazing 1812 rifle. He had participated in the efforts of his master and had shared his hopes. Returning to his country at Soemmerda (Saxe) in 1815, full of the idea of creating also a perfected model, he immediately set to work with untiring industry. In 1827, he made his first trials which lasted till 1840 and he had the joy of seeing his offspring adopted by Prussia in 1841. For twenty-five years this arm, remarkable as it was, passed unnoticed. It was only in 1864, during the Prusso-Danish campaign, and chiefly in 1866, after the storm of Sadowa, that one noticed the three great progresses made by the needle-gun: Ballistic progress by the elongated bullet, its forcing from the base and its regular rotation. Mechanical progress by a good locking system and by the priming in the cartridge. Tactical progress by the rapidity of firing and by the defilade of the rifleman, enabled to reload in all positions, whether kneeling, sitting, or lying down.

"The extraordinary victory of Prussia was explained by its immense superiority of armament, and Dreyse had the glory of seeing, in small arms, a real revolution which was the start of the present accomplishments. Pauly, on the other hand, the real precursor, whose amazing invention was wrecked with the Empire, is still almost totally unknown. It is often thus: the real and modest inventor prepares the success of a luckier and sharper adapter.

"In 1863, the Research Board of the Chalons Camp, created especially for the reorganization of our armament, acknowledged the ballistic superiority of the bullets with a receding base; but, being unable to reach a practical solution for this shape of projectile, it returned to the problem of maintaining the velocity by keeping a greater sectional density. In 1866 the Chassepot elongated cylindro-ogival bullet of a caliber of 11-mm. was created.

"In 1886 new progress was made along this line with the Lebel 8-mm. bullet, and another in 1891 by the Italian Paravicino-Carcano bullet, of a 6-mm. 6 caliber and by the Hebler-Krnka 5-mm. bullet.

"In 1895 we find a trail of bi-ogival bullet by Professor Hebler of Switzerland, who has, for the last 30 years been somewhere in all progress of armament. The point and the base of the bullet were traced on a very elongated ogive, very favorable to the flatness of the trajectory; but a central canal following the axis of the bullet had been left open inside, which considerably decreased the sectional density. The loss of velocity was extremely rapid and this bullet had no reach and no precision.

"It is certain that any modification in the exterior shape of the bullet and in its density varies infinitely its ballistic qualities. It is only by long trials, during which mathematics and experience control each other step by step, that one can find a real amelioration."

IN "The Rifle, its Theory and Practice," Arthur Walker (London, 1865), sets forth the form of projectile preferred by Sir Isaac Newton in 1687. That distinguished scientist recommended a cylindro-conoidal shape for projectiles. The following quotation from page 234 of this publication gives an interesting account of the accomplishments of Robins, an early British ballistician: "Again in 1742 we find that our countryman Robins, to whose extraordinary genius gunnery owes so much and to whose discoveries so little of value, comparatively, has been added, still more clearly defines what were the necessary conditions for the form of projectiles. First, he clearly proved the advantages of an elongated form of projectile; and secondly, that the center of gravity should be near the forepart; and with this view he proposed the use of an ovoidal or egg-shaped bullet which having the center of gravity in the fore part would fly more accurately in the line of the desired trajectory, the lighter end being constantly forced by the resistance of the air into the path of its required flight."

On page 238 of this publication there is shown a diagram illustrating the pressure of air on a moving projectile. The Piobert form of bullet is said by this author to be the best form for overcoming the air resistance. The author also recites that Tamissieur elongated the Piobert form of bullet to 7 calibers and obtained excellent results. This publication also states that General Jacob who always combined in an eminent degree practical experiment with theoretical consideration, came to the conclusion (1) that the conoidal form was the best shape suited for the anterior part or apex of the bullet; (2) that the conical and cylindrical parts should be one diameter and a half in length each so that the entire length of the bullet would be three diameters. It should be stated in passing that General Jacob was indeed a successful and practical ballistician whose name appears frequently in English publications in connection with bullets and artillery projectiles.

Also in "A Treatise on Ordnance and Armor" (supra), Captain Fishburn of the Royal Navy is quoted as stating that great advantages are to be obtained by increase in velocity in that the high velocity gives flat trajectory and therefore a great advantage where the distances are unknown. In stating this, Captain Fishburn clearly recognized the objective which ballistic engineers have been following during all the years subsequent to his statement. The following is quoted from paragraph 641, page 537, of this publication: "This first condition of high velocity is a light projectile. This does not necessarily mean a short projectile; the proper length for the greatest stability may be preserved by hollowing the projectile in such a way as not to displace the center of gravity, or better, by some modification of the principle adopted by Mr. Stafford."

FROM the foregoing it will be seen that even before 1865 those skilled in the art recognized the fact that a comparatively light projectile of high velocity and flat trajectory would be more desirable than a heavy projectile of low velocity.

The book, "Rifles and Rifle Practice," by C. M. Wilcox, U. S. Army (New York, 1861), contains interesting disclosures on the development of projectiles and the rifling of gun barrels. This publication also gives rather accurate information on the development of the various bullets of the world, and is particularly interesting as to description of service bullets of the various countries and their developments. Particular reference is made to the Prussian and Russian bullets, found on pages 183 and 185 respectively. These bullets are the type which were considered most advanced at this period and consisted of pointed bullets having grooves in the body portion which were filled with grease for the purpose of lubrication. On page 208 of this publication there are described some very interesting experiments by General Jacob. As an appendix there is found a most valuable representation of the types of army bullets in use during this period. This chart gives very definite evidence of the fact that at the beginning of the Civil War the form of bullets had reached a very high degree of experimental perfection. It is to be remembered that at this period of the development of the art bullets were commonly made of lead and while most of them were designed to be used with rifled guns, only a comparatively low velocity was attained.

In "Armor and its Attack by Artillery" (1887), Capt. C. O. Browne of the Royal Artillery describes the Palliser projectile. Palliser was an English ballistic engineer who took out numerous patents on the subject of artillery shells. The particular Palliser shell described by Captain Browne was a long-pointed artillery shell used with a sabot. On page 137 of this book there are described some interesting experiments with Palliser steel-jacketed shells fired from an 80-lb. gun against wrought-iron plate. Of particular interest to the present discussion is the fact that Palliser recognized that a long pointed shell gave more efficiency than one of small ogive.

The Italian publication "Corso di Materiale d'Artiglieria" by Capt. Giuseppe Ellena (1877), discloses some interesting forms of artillery shells. It is quite evident from the disclosures of this publication that the tendency towards long pointed shells for the purpose of increasing range was well known at this time.

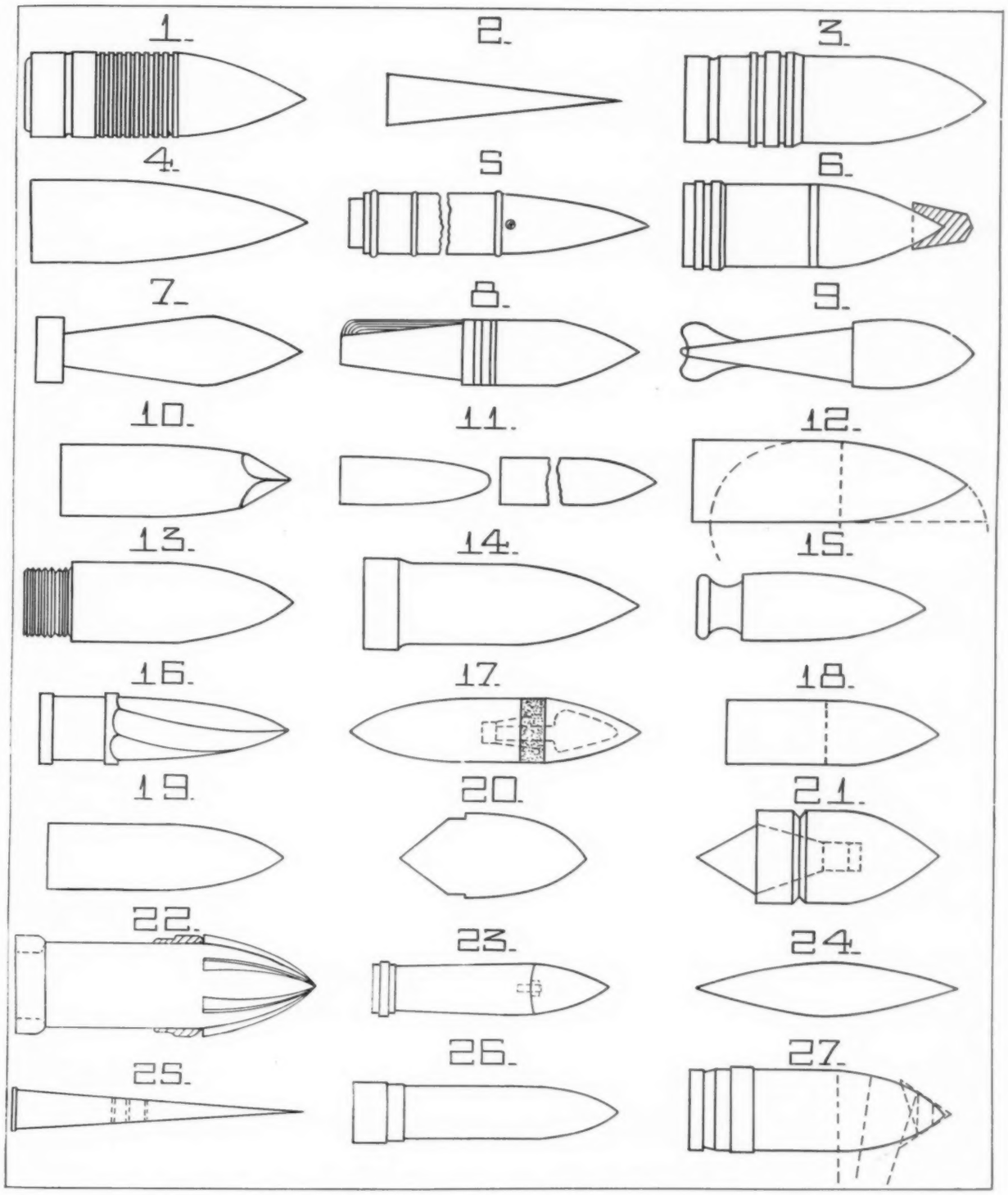
The book, "Treatise on Ammunition," England, 1897, published by authority of the Secretary of War describes the Nordenfelt machine gun cartridge and bullet. Here also are shown the forms of small arms bullets in vogue at this period. The Nordenfelt machine gun bullet was a 1-inch steel bullet which was rather long in character but which had a radius of but three times the caliber.

There is a most interesting article to be found in *Journal of United States Artillery* for July-August, 1901, which is a translation by Capt. Frank E. Harris of the Artillery Corps. The article refers to the form of the head of oblong projectiles which encounter the maximum resistance to motion from the air. In referring to the Piobert bullet it states that the form suggested would be unstable and hence lack precision of firing. The article which is concluded in a succeeding number of the Journal is an excellent discussion from a technical point of view.

In "Principles of Gunnery for Rifled Ordnance" by Maj. J. Sladen, Royal Artillery (London, 1879), reference is made to the Piobert structure and also to some experiments made by Bashforth with the clock chronograph to ascertain the amount of the resistance to the air to different forms of heads for projectiles, the rear portion being flat in each case. Professor Bashforth, an Englishman, did an enormous amount of experimenting with clock chronographs over a long period of years. His experiments are recorded in the books and are extremely interesting to persons desiring information on this subject.

"The Gun and its Development with Notes on Shooting" by W. W. Greener (London, 1881), shows various types of bullets popular at that time. There is shown on page 188 some bullets intended for large game shooting which were designed by General Jacob and which were characterized by being long, pointed, and of steel having a lead cylinder portion.

IN the development of shapes of projectiles the French seem to stand out as the most persistent experimenters. It would seem to be clear from various publications that the French not only are skilled in modern ballistics but were among the first to understand thoroughly the mathematics envolved. The state of the French art in 1896 is well set out in the publication "Organization du Matériel d'Artillerie" by E. Girardon (Paris, France). It is quite obvious from this publication which was written by a captain of the Artillery and professor of the French artillery school that the effect of wind resistance on projectiles and the relation



The Form of Some of the Projectiles Patented in Great Britain.

1. Brandon; 2. Farini; 3. Grenfell; 4. Trebor; 5. Unge; 6. Reichwald; 7. Hinton; 8. Parry; 9. Shipright; 10. Cole; 11. Simpson; 12. Hadfield; 13. Edmonds; 14. Lindenufer; 15. Johnson; 16. Fisher; 17. Parsons; 18. Palliser; 19. Mennens; 20. Lake; 21. Hazeltine; 22. Palliser; 23. Longsdon; 24. Hope; 25. Farini; 26. Day; 27. Page.

of sectional density, length and form of the projectile and the relation of each of these elements to each other was well understood at the time. This publication is not only interesting to those who understand the mathematics of the matter but is also interesting to laymen as showing the great strides which had been made by the French prior to that time. The following is quoted from page 118: "The weight of a projectile by sectional unity, is increased as follows: (1) for a given caliber, by lengthening it or by using for its fabrication, denser material; (2) for identical projectiles, by increasing the caliber.

"The lengthening is limited by the requirements of the regularity of the movement through the air. Thus, at the time of the adoption of the steel melinite shells with great internal capacity, one has been able to increase from 3 to 4½ calibers the length of the Bange projectiles; but by going to 5 calibers one would have sacrificed the regularity of the firing.

"The increase of the caliber is limited by the requirements of the service."

On the subject of general shape, the following is quoted from page 119: "The shape of the projectiles has a great deal of influence on sustaining the velocity; it is, in fact, necessary to help as much as possible the penetration of the projectile through the atmospheric strata, as well as the sliding of the molecules along its sides. For a long time the cylindro-ogival shape has been acknowledged to be the most advantageous.

"The exterior surface of the projectile should moreover be as smooth as possible in order to decrease the air resistance.

"The generating curve of the ogive is the arc of a circle the center of which o is on the diameter oo′ which limits the cylindrical portion of the shell and which is tangent to the generatrix of this cylinder.

"Experience shows, in effect, that the higher and the more pointed the ogive, for a given caliber, the less will be felt the effects of the air resistance. This is why the height of the ogive, expressed in calibers, has always gone increasing, in spite of the decrease of internal capacity which results from this increase, to arrive to the present Bange shells, in which, for a length of 3 calibers, the ogive is 1½ calibers in height.

"The point of the ogive is kept only for battering (armor-piercing) shells; in others it is replaced by a flat groove which serves as ground for the fuse, screwed in the fuse hole."

"Aide-Memoire a l'usage des Officiers d'Artillerie" (Paris, 1883), is a sort of handbook for French artillery officers. This handbook shows Bange projectiles for 155-mm. guns. The long ogive such as is found in the modern artillery shell is known in France as the Obus Bange. No definite information has been found setting the date on which these Bange projectiles were first used. It is believed, however, that they were in use by the French prior to 1880. The characteristic of the Obus Bange is that the head is curved on a radius of approximately 8 calibers. The shells shown in this publication were used with the ordinary nose fuzes and operated substantially similar to the modern artillery shell.

"Lecons d'Artillerie" by E. Girardon (Paris, 1899), is a treatise on the effect of the resistance of the air on projectiles. On page 90 following it is stated that the resistance of the air is dependent upon four rules: (1) the resistance is proportional to the right section of cylinder envelope of the projectile parallel to the direction of flight; (2) it is proportional to the square of the speed of the projectile; (3) it varies with the form of the projectile and with the condition of the surface thereof; (4) it is proportional to the sectional density. It furthermore states that the laws as set forth above are capable of mathematical computation in theory and have been confirmed by experiment and experience. The third rule is of particular interest to the present discourse as showing the knowledge of those skilled in the art with reference to projectiles in general prior to 1899, with particular reference to the best form of projectile. The following is quoted from page 92: "The air resistance varies according to the shape of the projectile and to the condition of its surface.

"Its intensity is of course decreased if the penetration of the projectile through the air is facilitated by giving its anterior part the shape of a point, or better still of an elongated ogive instead of a flat or rounded nose. Thus it is for a boat, the keel and forward part, or bow, of which are pointed and which meets with less resistance from the water than a boat with a flat bottom and a square bow.

"Moreover, by making the surface of the projectile as smooth as possible, the sliding of the air molecules along its walls is aided, which results in a decrease of air resistance."

Again on page 94 with reference to this same subject, the author states that: "The loss of the velocity of two projectiles, identical in caliber and made of the same material, is in reverse proportion to their length. It is therefore more advantageous to use very elongated projectiles; however, when dealing with lands, it will be seen that there is a practical limitation to this elongation."

IN conjunction with the foregoing there should be considered the large number of patents on projectiles which were obtained in the various countries. Records of the United States patents may be readily obtained by consulting the index of the *Patent Office Gazette* or by a search conducted in the U. S. Patent Office in Washington. While a large number of foreign patents are on file in the Patent Office it is thought best to include in this paper some of these patents, particularly those issued by Great Britain which have a bearing on the subject. The following British patents are selected as indicative of the general state of the art in Great Britain and have a particular reference as prior art to the present long-pointed bullet:

Patent No. 5393 of 1881, issued to Brandon, shows a pointed artillery shell; No. 5366 of 1887, to Farini, discloses a conical bullet with a very long head; No. 16,867 of 1891, to Grenfell, shows an artillery shell having a long pointed head. No. 6911 of 1894, to Trevor, shows a long pointed projectile having longitudinally disposed conoidal ribs intended to accomplish a twisting movement of the projectile.

Patent No. 25,945 of 1896, issued to Unge, discloses an extremely long shell having a long head, the curve of which is struck on a large radius. No. 1879 of 1900, to Reichwald, shows a projectile having a long pointed head, to the point of which is attached a soft metal cap for the purpose of aiding penetration. No. 21,653 of 1897, to Hinton, shows a pointed projectile of a peculiar type having a tapered rear portion; No. 21,116 of 1898, to Parry, is for a projectile with a pointed head and having a stream-lined rear portion.

Patent No. 8132 of 1901, issued to Shipwright, shows a long pointed projectile of a peculiar type; No. 7323 of 1901, to Cole, discloses a substantially pointed projectile, the point

of which is sharpened for the purpose of aiding the penetration of the shell.

Patent No. 4520 of 1901, issued to Simpson, relates to a gas check, but in the drawings are shown a long pointed shell and a long round-nosed shell as interchangeable for using the invention.

Patent No. 20,311 of 1903, issued to Hadfield, discloses a method for design of a pointed projectile, the head of which is about one-third of its total length. No. 3967 of 1903, to Edmonds, is for a pointed headed bullet.

Patent No. 18,601 of 1904, issued to Lindenufer, a German engineer, relates to gas checks. In the drawings, however, are shown, but not claimed, the application of the invention to many types of projectiles. This inventor makes no claim to the shape of the projectile, although he discloses fifty-three figures of various forms of projectiles, including long projectiles having long pointed heads. No. 1678 of 1855, to Johnson, discloses a rifle and a projectile therefor. The patentee describes drawn bullets and shows as what he considers the best form of rifle bullets three types of projectiles, all of which have long pointed heads.

Patent No. 1573 of 1859, issued to Fisher, relates to a cannon and shot therefor. The head of this projectile shown as the preferred form has grooves intended to give it a twisting movement in flight. No. 720 of 1860, issued to Parsons, discloses a fire arm and projectiles therefor. The patentee states: "The object of my improvements in projectiles is to make them of such a form as will diminish as much as possible the resistance to their passage through the air, and also so to construct them that the center of gravity will be well forward. For this purpose, I make them externally of an elongated form, with both the front and rear ends conical, conoidal, or otherwise pointed or rounded, * * *."

Patent No. 1334 of 1863, issued to Palliser, relates to projectiles for ordnance. On page 2 of the patent the following is found: "Fig. 1 represents a projectile with a long conical head, which I have found in practice to be a favorable form of cone for these descriptions of projectiles."

Reference to Fig. 1 shows a projectile having a pointed head of substantially one-half the total length of the projectile, the body part being a cylinder, the radius of curvature of the head appearing to be between three and four times the caliber. No. 2695 of 1866, to Mennens, relates to a rifle and a cartridge. Here reference is made to a cartridge especially adapted for the gun, and is described as a cylindro-conical projectile of any desired metal.

Patent No. 2393 of 1866, issued to Lake, relates to projectiles. It states: "I am aware that bullets have been made of a conical shape with a flat base, or a slightly rounded base, or with a hemispherical base, and I am also aware that a bullet has been made whose hemispherical face and conical base have been united by a cylindrical portion, * * *. In my bullet the rounded face is so prolonged as to make a comparatively sharp point, and it embraces so large a portion of the metal of the projectile that the center of gravity is thrown forward of the cylindrical portion, which is a necessary feature where accuracy of motion is to be secured." In claiming his projectile, this patentee stated: "I claim an elongated pointed projectile having a cylindrical portion to fit the bands of the bore and a conical rear, the center of gravity being in advance of the said cylindrical portion."

Patent No. 126 of 1873, issued to Hazeltine, relates to projectiles for rifled fire arms and ordnance. The projectile described and claimed is pointed, parabolical and elongated, formed with a rear cylindrical portion comprising a wooden cone-shaped peg, which latter shape is intended to guide the projectile so far as wind resistance from the rear of the projectile is concerned. The projectile as shown in the drawing has a head approximately one-half of the total length of the projectile proper. No. 3191 of 1880, to Palliser, describes a projectile intended for penetration of armor plate, although it may be used for other artillery purposes. The following is quoted from the patent: "The body of the projectile is cylindrical, smaller than the bore of the gun. Its head extends in the form of a long pointed conoid, the conoidal part being cast with a number of longitudinal ribs, by preference of triangular form, projecting from its surface."

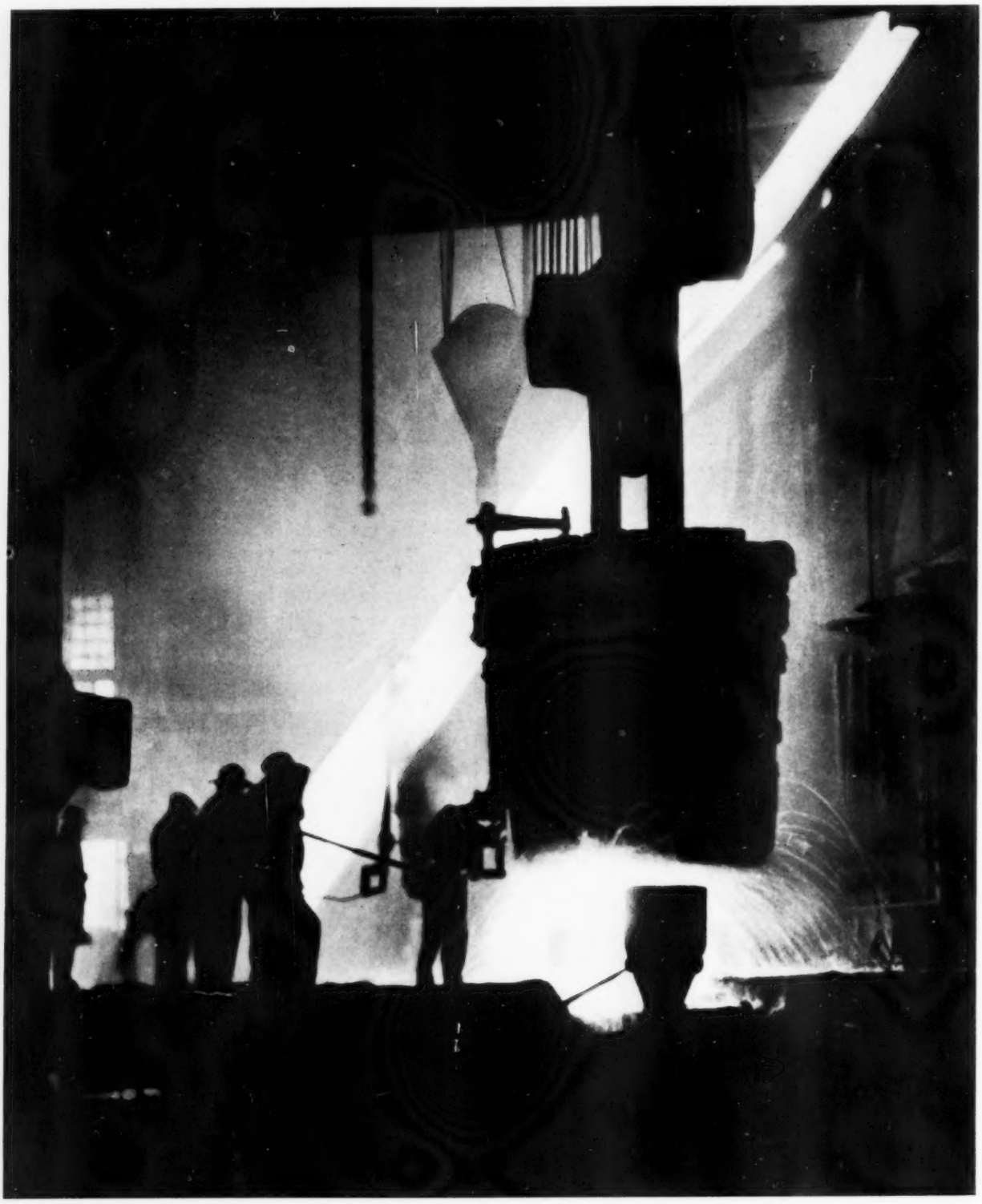
Patent No. 566 of 1883, issued to Longsdon is particularly important. It is obvious from the discussion in this patent that long shells having ogival shaped heads were well known before 1883. The reason for pointing the shell and the effects of lengthening the shell are clearly explained. The patent itself relates especially to a false ogival nose on elongated shells for the purpose of minimizing wind resistance.

No. 14,915 of 1884, to Hope, relates to a small arms cartridge. The bullet portion "f" as shown in the drawing is long and pointed at both ends. The claimant expressly disclaims such form as his invention. The reference is cited merely as a peculiar form of long bullet. No. 3985 of 1887, issued to Farini, relates to a small arms projectile and describes the cartridge in concise form as follows: "The improved conical bullet in combination with and forming part of the wedge-shaped conical cartridge thereby allowing a smaller caliber gun to have the same weight bullet with a much increased length and giving less resistance to the air."

In patent No. 15,251 of 1889, issued to Day, an American officer, the bullet described and shown is a long pointed one.

No. 18,204 of 1902, issued to Page, describes the projectile claimed in this patent in these words: "The radius of longitudinal curvature chosen for the base portions of the point should be from 2.25 to 4 times the caliber, though it is not apparently absolutely limited in principle to this range."

The foregoing discussion and references cited are intended to bring the art down to the point where the modern sharp-pointed bullet began to be developed. There has been a great deal of discussion and dispute in determining where the credit for the modern bullet should be placed. The Germans have declared to the world that they originated the modern bullet and statements of this character are found in numerous publications. On the contrary, the French publications pointedly state that the original modern rifle bullet was designed and developed in France. While the Swiss do not appear ever to have made any claim to have been the first to adopt the pointed bullet, the work of some of their ballisticians in this direction is such that it should be given consideration. While the Americans admit that the French and Germans adopted the modern bullet before the United States, the majority of those skilled in the art are inclined to the belief that the art progressed logically and that circumstances were, for the most part, responsible for the radical changes in the forms of projectiles between 1900 and 1906. The writer has made a careful study of all available facts and without attempting to argue the matter will set down the facts as they were found in publications and as they are gleaned from recognized experts. (*The concluding part will be published in the next issue of this Journal.*)



Studies in Steel, The Essence of Ordnance

I. THE GIANT HEAT

The First of a Series of Photographic Studies by Mr. John P. Mudd for the Midvale Company

Mons Meg—A 15th Century Bombard

Pioneer Siege Weapon of the Era of Powder and Projectile

By R. N. Appleby Miller*

WITHIN the grim walls of "Edwinesburgh," or the Castle of Edwin, King of Northumbria, that far-famed hold which, perched high upon a rock, scowls down upon "Auld Reekie," Scotland's premier city, is a hugh piece of ancient artillery known to the world as "Mons Meg," a 15th century bombard. It is placed upon an elevated gun platform and stands in front of St. Margaret's Chapel as if defending it from the attacks of infidels. This ancient weapon, whose history is wonderfully mixed-up with legendary tales and stark realistic facts, some of these latter having at various times caused us Northumberians no little discomfort, is probably about four hundred and fifty years old—perhaps a few years more or less.

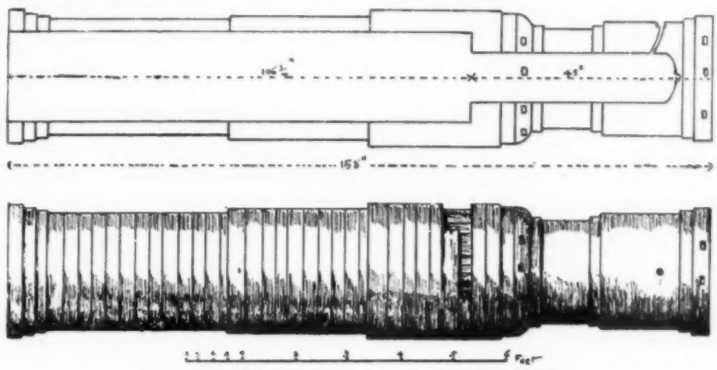


Fig. 1. Method of Construction of Mons Meg.

This "Ane grit peice, of Forgit yron, callit Mons" regularly occurs, down throughout the years in the Exchequer documents of Scotland. In 1489, 1497, 1501, 1527, 1532 and 1539 payments were made for her reconditioning, etc., and also for her carriage, or "cradill." On one occasion she was "ourelaid with reed leid" and her "Quheles (wheels) and extreis creischit (axletrees greased) with Orkney butter." She has also been recorded in history under other names or variants of the same name:—In 1650, when Edinburgh Castle surrendered to Oliver Cromwell, Mons is written of under a new designation "The great Iron Murderer called Muckle Meg," and again as "the Great Mag." In 1680 she is written down as "Muns Meg."

THE legendary construction of the gun makes excellent reading because of certain facts which have since come to light, some of which strongly support the tradition that a gun foundry did actually exist at a place called Carlingwark, where tradition says Mons Meg was forged.

In 1455 James II, "Fiery Face" of Scotland, laid siege to the Castle of Thrieve which, built in the year 1372 by Archibald the Grim, was 83 years later successfully withstanding the total weight of all the artillery James could bring to bear upon its walls. The peasantry of the district did not love the Douglas, and their sympathies were entirely with the king. Amongst the large crowd which daily watched the progress of the siege was one who bore the nickname of *Brawny Kim*. His real name was William M'Kim. He was by trade a blacksmith, and with the aid of his three sons—some stories say seven sons—he worked a forge at Buchancroft near the Three Thorns of Carlingwark.

M'Kim sought an audience with King James and offered to make a "chamber" powerful enough to batter down the walls of Thrieve in two or three discharges. All the king had to do was to supply the iron bars, and Brawny Kim and his sons would do the rest. M'Kim said he would build the bombard just as a cooper builds, or makes a casque, *i.e.*, staves hooped with bands. The rest of the peasantry would go to the granite quarry on Bennan Hill and there make stone balls for the bombard to hurl against the hated walls of Thrieve. In a wonderfully, in fact too wonderfully short time, the gun was ready. It was hauled to the top of a hill, since called Knock Cannon, and from there it fired upon Thrieve. The "charge consisted of a peck of powder and a granite ball the weight of a Carsphain (Galloway) Cow."

In the wall of the castle fronting the hill there is a huge hole still called the "Cannon Hole." Tradition says this was the result of the first kiss "Mollance Meg" gave the hold of Archibald de Douglas, surnamed "the Grim."

The first ball fired went clean through it and carried away the right hand of the "Fair Maid of Galloway," just as she was in the act of raising her wine cup while seated at the banqueting board. In 1810 as if to prove this latter claim there was found amongst the ruins a massive gold ring bearing the inscription "Margaret de Douglas." King James was so pleased with the destructive qualities of M'Kim's bombard that he created Kirkcudbright a royal borough and granted to Brawny Kim and his heirs and successors, the forfeited lands of "Mollance."

The cannon received the sobriquet of "Mollance Meg" in honour first of M'Kim's new lands, and second of his wife Meg, whose voice was remarkably loud, so loud indeed that the soldiers likened it unto the bombard's roar. In course of time this name was shortened into "Mons Meg." As if to prove that legend and tradition can be depended upon, a large and deep bed of cinders and iron scoria was discovered at Carlingwark, when preparing the ground for a new road to Portpatrick. This was probably the remains of Brawny Kim's great forge.

We know that James II was killed on 3rd August, 1460 by the bursting of a large new bombard then being used against Roxburgh Castle. "The King, more curious than became him, did stand near hand the gunners when the artillery was discharged: his thigh-bone was dug in two with the piece of a misformed gun that brake in shooting, by which he was stricken to the ground and died hastily."

*Lieutenant, F. L. A. Published by permission of The Edgar Allen News, Sheffield, England.

THE great gun, Mons Meg, consists of chamber, first and second reinforce, and chase, the chamber being the strongest. A rent near the juncture of the chase and the breech shows the method of construction . . . (Fig. 1 bottom illustration). This fracture was caused by overloading (too strong a charge of powder) the gun when firing a salute upon the occasion of a visit made by the Duke of York in 1680, to Edinburgh.

Sir John Lauder, of Fountain Hall, records this event thus:—"In October 1680 the Duke of York having visited the Castle of Edinburgh,—for a testimony of joy, the gun called *Muns Meg* being charged by the advice of ane English Cannonier, in the shooting was riven; which some foolishly called a bad omen. The Scots resented it extremely, thinking the Englishmen might have done it purposely, they having no cannon in all England so big as she." They of course lost sight of the improved quality of the gun powder then used. Mons Meg is built-up of wrought iron bars each 2½ inches thick, welded together on a mandrel, and then hooped with iron rings or coils, 3½ inches thick. These rings were shrunk on, *i.e.*, put on hot and driven tight up one to another, and then allowed to cool. Guns of their construction are very similar indeed to the Armstrong gun: a weapon built 400 years later.

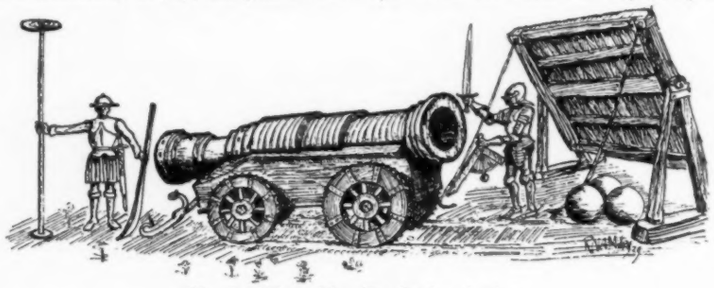


Fig. 2. Mons Meg Ready for Action.

Mons is 13 feet 2 inches overall in length, *i.e.*, from the butt of the breech to the muzzle. The bore of the barrel is 1 foot 7½ inches in diameter. The diameter of the chamber is 11 inches. (Fig. 1, top illustration). The total weight is 5 tons. The powder charge was 105 lbs.; the weight of the shot if of iron, 1125 lbs., and if of stone 549 lbs.

The range at an angle of 45° with an iron ball was 1408 yards, and with one of stone the ground covered 2867 yards —good for 450 years ago! In Fig. 2 the officer in full armor holds in his left hand a gunners' quadrant of the period.

Here is an official record of Mons' shooting. On the 3rd of October, 1558, the following payment was made by the Queen Regent in consequence of the discharge of the gun at the rejoicings for the marriage of Mary Queen of Scots with the Dauphin of France.

"To certain pyonaris for thair labouris in the (bringing) of Mons furth of her lair, to be schote, and for the finding and carrying of her bullet efter scho was schot, fra Weirdie Mure (fully two miles from Edinburgh Castle) to the Castell of Edinburgh."

In 1633 Mons was found to be in such a corroded condition that she was not able to fire a salute of welcome to King Charles I upon his visit to the Castle of Edinburgh. "Item, to . . . for rining and winning the tuich hole of the iron peice that had beene poysoned thir many yeares by gane iijd."

In the year 1754 Mons Meg was taken to the Tower of London, and there is a record for compensation paid for damage done during transit.—"1754 John Dick applies to the Board of Ordnance for compensation for injuries received to his vessel and hawser in shipping the great gun at Leith for conveyance to the Tower."

An authority writing of this veteran gun says "In Mons Meg we have an excellent example of a bombard of about 1460, though the first mention of her occurs in connection with the expedition of James IV. to besiege Dumbarton." This is not quite correct: it was used at the siege of Thrieve in 1455, as of course has been mentioned earlier in this record.

The inscription placed upon Mons Meg's modern carriage (made at Woolwich in 1836), by Sir Walter Scott, at whose request the gun was returned, one hundred and three years ago, to Scotland (1829) and placed once again in Edinburgh Castle, states that it was forged at Mons. This is undoubtedly the case, as it is often referred to in the Treasurer of Scotland's Accounts as "Monns," "Mons" and "Monsis." The affix "Meg" which may have been applied to the bombard by the soldiery and the populace from its first landing in Scotland, does not appear, however, in any of the national records before the 17th Century.

The Exchequer Rolls for Scotland show that a bombard called the "Lion" was imported from Flanders in 1460, and there is also an account paid as compensation to the shipmaster for damage done to ship by the gun in hoisting it aboard at the port of loading. They also record expenditure upon Mons Meg:—

"1489 Item gevin the gunnaries to drink silver quhen thai cartit Monss be the Kingis commande . . . . . xviij s.

"1497 Item the samyn day (x day of Aprill) giffin Johne Mawar elder in part payment of the quhalis (wheels) making to the bombardis and Mons . . . . . iiij lib."

Mons Meg was originally made in two sections for ease in transport. These were screwed together when required for action.

The square lever holes for turning can be plainly seen in the rear-ends of the chase and chamber. When being transported in two parts the gun would require forty-eight horses for each wagon.

The difficulty, however, of screwing and unscrewing the gun seems to have finally decided its permanent state. For we see it in one piece, mounted upon its cradle, which is in turn mounted upon wheels, carved upon a stone slab which once formed part of the transome to one of the gateways to Edinburgh Castle (Fig. 2).

This mediæval carriage is described, along with the furnishing for the bombard, in the Scottish Treasurer's Accounts for the year 1497-8 when Mons Meg first turned her attention to the English Border and Norham Castle: the Bulwark of the Bishopric of Durham. It is written thus "A New cradill June 24-1497. Item, to pynouris to bere ye trees to be Mons newe cradill to her at St. Leonard's quhare scholay iij sh. June 28, Item for xiij stane of irne to make grath to Monsis new cradill and gavilokkis to go with hir, xxx sh. iiij d."

IN 1497 when Richard Fox was Lord Bishop of Durham, King James IV of Scotland laid siege to Norham. He had avowed himself a supporter of Perkin Warbeck who called himself Richard Duke of York and laid claim, as legitimate heir, to the Throne of England. James is credited with having given as his excuse the following, "he would onely forbeir to invaide the boundis quha wold assist to Richard Duik of York and non uther." So James to help this pretender invaded England with all his power, Warbeck being in his entourage, and settled down before Norham and for fifteen days he battered the walls of this ancient fortress. James used, along with his other artillery his "greet gonnes one of irne," Mons Meg. He had in 1497 brought Mons, on a "stock" (carriage) made at St. Leonard's Craig, from Dalkeith to Holyrood House; and the Exchequer Roll records it thus: paid, those who brought "Hame Monse and the other artailzerie from Dalkeith." Later, *viz.*, in August, 1498, he carried it, along with his other "artailzerie" into England and laid siege to Norham Castle. But the Bishop of Durham had placed two good and well tried soldiers in command of the Castle, *viz.*, Thomas Garth, the Captain of Norham, and Lieutenant Hamerton, his second in command. These men so inspired their soldiery that after fifteen days of siege and assault by cannon and escalading the Scots drew off and James "seeing that he couth not win the same, albeit that he had done great domage and skaith thereto, he returnit within his realme." The great damage amounted to "the fall of one tower" and Mons Meg had been used at this siege. For their fine defence of the "Castell of Norame" Bishop Fox granted Garth and Hamerton an annuity of 5 marks for life.

We are not informed whether the garrison essayed any sorties with a view to spiking Mons and her lesser sisters as was done elsewhere even at this early date.

MONS MEG'S next appearance before Norham was when James IV came "with his puissance" on the 22nd of August, 1513.

Sir Richard Cholmeley was Captain of the Castle and he on this occasion did his best to keep the promise he had made to the Earl of Surrey, *viz.*, "That he would keep the King of Scots in play till the King of England came out of France." Sir Richard had not, however, counted upon the marked improvement in the gunnery of the Scottish bombardiers—artillerymen. During the years 1497-1511 the Castle had been thoroughly repaired and once again put into a state of defence, costing the Bishop £750 12s. 2d. A new Lord Bishop occupied the throne in Durham Cathedral, Thomas Ruthall, and he too had spent much money upon the setting in order of the Bishopric's outpost tower. He wrote of the money he spent "The Hospitality of this country agreeth not with the building so greate a wark, for that I spend here wold make many Touris." Now however, the men serving the guns were experts and knew how to place Mons Meg with a view to getting the best results. They had had plenty of practice in Scotland and soon demonstrated that to Sir Richard and his men. King James had brought up his train of French and Flemish artillery, *viz.*, the "Seven Sisters," or "Bothwick's Culverins" and Mons Meg the great Flemish bombard of 8.102 calibres. The horses—or more probably oxen—and equipment for this gun alone would be very great: fourteen or so wagons would be necessary to carry say the sixteen great stone shot with the requisite amount of powder and the great wooden discs to be used as wads; forty-eight pairs of horses to haul the gun; six horses to transport the mantlet, or screen for the protection of the cannoniers, or artillerymen; also waggons for carrying these gentlemen with their picks, shovels, crowbars, braziers for lighting the linstocks, or match, for "touching off" the gun, etc.

Mons Meg was placed in position in the middle of Norham's village street, from which vantage ground she commenced on the 23rd of August operations against the barbican and its southern curtain wall which protected the outer ward of the castle.

After two days of bombardment the defences were completely reduced to a shapeless mass of ruins, and the Scottish troops took the outer ward by storm. Having captured the outer ward, the Scots turned their attention to the inner ward, but upon this latter they could make no impression, although they did succeed in damaging the Keep and the Chapel. This inability to breech the inner ward was, no doubt, due to the difficulty of moving the bombard, weighing 5 tons without its carriage, to within effective range for direct hitting, owing to the heaps of broken masonry. Also the effective fire of the defenders' own artillery, which, though of shorter range than that of the Flemish bombard, would, upon its coming near, become dangerous to those manoeuvring Mons Meg into her new position, not to mention her cannoniers or gunners when serving her in spite of the protection afforded them by her great wooden mantlet covered with rawhide and studded with nails. However, on the 29th of August, Sir Richard Cholmeley surrendered Norham Castle owing to the looked for relief failing to arrive, thus ending the historic 7 days' siege. Mons Meg must have been immediately withdrawn and transported into the safety of the Scottish Marshes, as it was not amongst the artillery captured at Flodden, when 30,000 Englishmen defeated 40,000 Scots. So, by laborious transportation, Mons Meg must have regained gradually the sanctuary of Edinburgh Castle, where she remained until taken, in 1754, to the Tower of London. There she "lodged" until the year 1829.

Bishop Ruthall of Durham, writing on the 24th October, 1513, to King Henry VIII's Almoner, Wolsey, says:—"As touching the Castell of Norham, thanked be God and Saint Cuthbert it is not so ill as I supposed."

It is interesting to note, in passing, that one of Mons Meg's great granite balls, eighteen inches in diameter, still lies within the ruins of Norham Castle where it was hurled, by the great Flemish bombard, in either the 1498 or the 1513 siege, after having been transported by ox-drawn waggons over rough broken rain sodden ground all the way from Galloway where it was quarried.

"Mons" has quite a number of battle, or perhaps it would be better to write siege honours to her name, they are as follows:—Thrieve Castle in 1455; Roxburgh Castle in 1460; Dumbarton Castle in 1489; Norham Castle in 1498 and again in 1513; The Defence of Edinburgh in 1650. This last was her final growl during war; her others were sharp barks of joy until she was "riven in 1680."

Captain James Grant—the novelist—in his romance "The Captain of the Guard," has a chapter describing the making and firing of Mons Meg, the famous 15th Century bombard, in which he writes from a novelist's point of view.

New Armament of the Swedish Army

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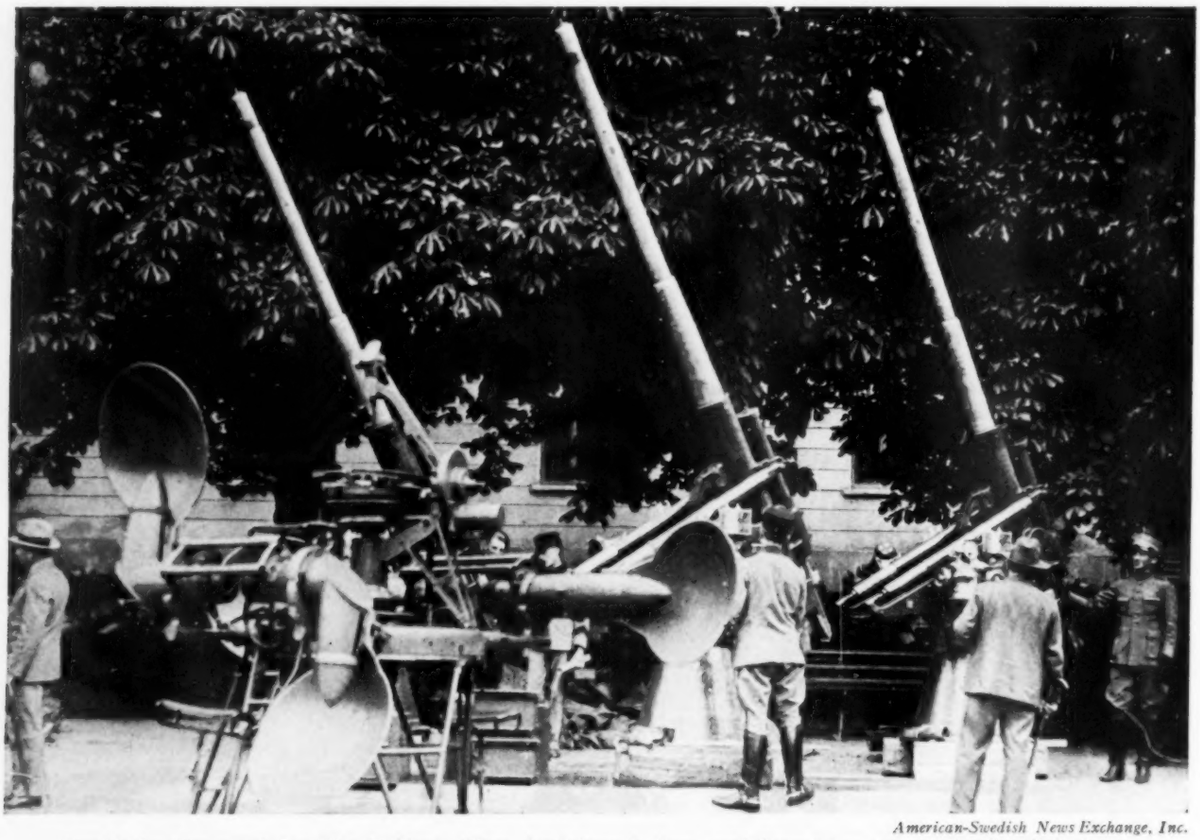

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Possibilities of the "Air Tank"

Part VII: Navies and the Airplane

By Fred. H. Wagner*

IN approaching the conclusion of this series of articles, I would begin with a quotation of the late Marshal Foch, "The military mind always imagines that the next war will be on the same lines as the last. That has never been the case and never will be. One of the great factors in the next war obviously will be aircraft. The potentialities of aircraft attack on a large scale are almost incalculable."

In addition to this quotation, I must again cite the great French Marshal, "The infantry needed guns, tanks and airplanes, but these did not win battles and were only *accessories*. It was the infantry that won battles. . . . It was an idea of amateurs that tanks and airplanes could win a war."

Here we have two statements that are somewhat contradictory; the first that the potentialities of aircraft attack on a large scale are almost incalculable, and the other that tanks and airplanes, being only accessories, cannot win a war. It is no doubt true that the first statement contains a concrete fact, but our isolated situation, unless we must fear attack from either our northern or southern border, permits us to make provisions to ward-off such an attack on a "large scale," and this at the same time covers the second so far as land warfare is concerned. However, I have serious doubt regarding our means for doing this in the case of the Navy, because the latter will have to bear the brunt of attack when it is launched against us from the sea. In consequence of the doubt it will not be amiss to examine into the evolution of naval warfare to draw some conclusions for the present day.

FROM the first dawn of history we find the existence of nations dependent upon maintaining communications which, in those early days, were principally overland trade routes, communication by sea remaining a hidden means until the advent of the Phoenicians, the world's first real navigators, a fact which brought this people both wealth and power. We next come to the Punic wars, fought between Rome and Carthage; here the Romans gained the final victory because of their superior knowledge in the handling of war galleys, and for which they had developed strategy and tactics superior to those of the enemy. These galleys were propelled by oars, and any sails which may have been provided were only an auxiliary motive power.

Since the power of the Romans depended principally upon their magnificant road system, the sea as a means of communication being of secondary importance, anarchy and ruin soon reigned on the sea upon the disintegration of Rome. The Saracens took command of the Mediterranean trade routes, but no semblance of order was restored until Venice assumed command of the sea. Genoa, perceiving the immense value of this sea-borne trade, soon made a bid for the mastery of the Mediterranean, and this was followed by the fleets of the Spaniards.

The strategy and tactics developed for these great fleets of galleys was as well thought out as is any today, and these methods of sea warfare obtained until the Dutch and the English so advanced the art of sailing ships that man-rowed galleys became obsolete for both war and commercial purposes. The art of sailing against the wind was the next step in advance and this, combined with improvements in navigating instruments, soon made long ocean voyages safe. Since the sailing ship made it possible to mount cannon on each side of the vessel, the weight of gun-fire increased beyond anything the galleys could offer, because the latter, being propelled by muscular power, had to be light in structure, hence they could mount only bow and stern guns of any weight. Thus the glories of both Venice and Genoa went into eclipse, and the world's trade no longer depended on the Mediterranean alone.

THE sailing ship made possible the establishment of colonies in the then almost unknown portions of the world, and thus made the acquisition of great foreign empires possible to the Spanish, Portuguese, French, Dutch and English peoples, bringing them great wealth through the opening of these new avenues of trade. The advent of steam power spelled death to the sailing ship in the development of civilization, and its concomitant, sea warfare, since it was now possible to provide the war vessel with protection in the form of side armor. This was followed by the construction of all-iron ships which, however, did not have an easy birth in some quarters. For example, we find the Admiralty Board in England assembled on a momentous occasion to debate the advisability of building such a monstrosity as an iron ship, and it was at once decided that the proposition was extremely foolish because iron would not float. The advent of our MONITOR during the Civil War, however, gave a great impetus to the building of "ironclads" for war purposes, because it had been observed that "iron would float."

In spite of steam motive power, it still seemed impossible to retreat from masts, yards and sails, and we find the early ironclads equipped almost like a sailing ship of a past generation, and from which England was taught a rather severe lesson. The success achieved by the MONITOR had finally taken root in the minds of the British Admiralty, and at the urgent behest of the latter, Parliament finally authorized the building of the CAPTAIN, propelled by steam power, but at the same time equipped with "enormous masts, yards and a great spread of canvas." All this superfluous rigging made the vessel extremely top-heavy, notwithstanding which the CAPTAIN started out on her maiden voyage with all sails set, but which added very little to her speed of fifteen knots under steam. On September 6, 1870, while off Cape Finisterre, she was struck by a heavy squall; she "promptly capsized with the loss of five hundred officers and men," including her designer, Captain Coles. It was *lese majeste* to discard masts and yards entirely, and the later turret ships were equipped with a bare mast and yard for signalling purposes. In spite of these troubles, development naturally continued, and the struggle between armor and guns began; the armor became thicker and thicker, and the guns became heavier in consequence, the start of an unending evolution.

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Now came a new weapon which brought fresh troubles to the naval constructor. The advent of the mobile torpedo gave birth to serious thought, but this new menace was answered by building bigger and bigger ships, until the super-dreadnought arrived. Here we have the final (?) answer to naval warfare, a ship carrying armor which can, in most cases, not even ward off the enemy's shells; provided with long-range guns which are supposed to, and which do, pierce the enemy's armor; equipped with large numbers of rapid-fire guns to keep off torpedo-boats and destroyers; in which under-water protection is sought through bulges which are supposed to prevent the effects of explosions reaching the ship's vitals, this being assisted by subdividing the hull into water-tight compartments in order to localize damage. Finally, the new menace, aircraft, is to be kept at a respectful distance by means of antiaircraft guns.

Unfortunately, however, such a sea monster has as yet not been provided with a gas-mask.

This immense floating fortress is also in danger from submarine mines, not to mention the submarine boat with its under-water torpedoes. This is the last word (?) in naval construction, but its value is extremely difficult to define, since it is a vessel costing forty-five to fifty million dollars, vulnerable to the enemy's guns, torpedoes, aircraft and poison gas. The latter is a most definite danger to which perhaps not as much thought has been given as the problem warrants, since the interior of this fortress must be supplied with fresh air drawn by fans from the outer atmosphere and which latter may contain sufficient poison gas, laid by a squadron of seaplanes, to kill the entire ship's crew confined below.

Since many of my readers are no doubt unacquainted with the axioms governing naval warfare, and since a knowledge of these conditions is necessary to appreciate the new factor, aircraft, which has entered upon the scene, a short discussion of these axioms must be permitted me. It is of course impossible for me in this short article to discuss any of the technical or tactical questions pertaining to naval warfare, but the advent of the airplane threatens to so revolutionize our preconceived ideas that what is now practice must be made clear to the reader.

IT seems highly unthinkable that our country will ever be called upon to defend its northern border, and it does not seem probable that a major war will ever be fought on our southern frontier, hence our danger consists in aggression along our lengthy eastern and western unfortified coast lines. In our isolated position we may at some time have to fight on foreign soil, and this will be possible only with the aid of a fleet, since it will be necessary for the latter to attempt to clear the sea of all hostile warships in order to establish communications between our shores and those of our enemy.

It will also be the duty of the fleet to reduce the enemy coast defenses, as well as to remove or destroy any mines which might prevent the landing of our troops. The fleet must also protect the transport of troops, must prepare and cover a suitable landing, and must finally make secure all communication lines of the landed forces when they lead across the sea. It is also required, in case of failure or defeat, to make possible the safe reëmbarkation of the landed troops, since this is possible only under cover of the ship's long-range guns. All these duties require that our naval forces must first defeat those of the enemy and blockade the hostile ports while, at the same time, rendering attempts of auxiliary cruisers, such as the Emden and the Moewe in the recent war, of no avail.

So much for aggressive action, but in a defensive war the fleet must defeat the enemy at sea to prevent a hostile landing on our shores, and it must keep open any avenues of sea communication required to bring in supplies of any kind. Fortunately, we are not in the same position as are many other nations in this particular, since we can safely say we are practically independent of foreign sources of supply except in a few products which can probably be taken care of anyhow. Should the efforts to defeat the hostile fleet at sea end in failure, thus opening the way for the enemy to effect a landing, the defending fleet must be constantly on the alert to disturb or cut off lines of communication between the landed forces and their home base.

WITH regard to the defense of our overseas possessions, which are in no manner of means protected by an abundance of fortifications, the fleet must necessarily act offensively against the enemy. It must attack and defeat him, and it must destroy any transport fleet aiming to land troops, but if all this is impossible, and if our overseas possessions are not provided with sufficient troops to defeat any landed forces, and which, unfortunately, is our case at present, we must be satisfied to abandon these possessions for the time being, and which might even mean their eventual loss.

Both our offensive and defensive actions at sea are strategic ones, for if offensive we will seek and attack the enemy, will reduce his fortifications, and will blockade his ports, besides doing as much damage to his sea-borne trade as is possible; if defensive, we must await the enemy attack, looking to our own coast for support, and we must also do everything possible to prevent the enemy carrying out his offensive intentions. Tactics, as known to the land forces, disappear in modern sea warfare, except in the case of the different types of ships which may compose the fleet, because both fleets will make use of absolutely the same means under the same conditions. It is impossible to think of a fleet waiting to be attacked while lying at anchor, because its doom would be certain, and it is also certain that a fleet, whether at anchor or under way, will be attacked by torpedoes and must defend itself against them, consequently such attack and defense is represented by the various types of ships present. In the case of destroyers, they can proceed on the offensive, while the opposing battleships can retaliate only with gun fire. This condition will always remain the same, even though the destroyers are engaged on the strategic defensive and the battleships on the offensive. The fleet, however, even when it is engaged on strategic defensive, always acts tactically only on the offensive, as when it puts to sea to attack the enemy fleet.

The sea recognizes only active defense, although this defense may be supported by mines and coast fortifications, hence the defending fleet possesses the advantage of being able to retreat under the shelter of its own land fortifications; it also has a base, consisting of docks, repair shops, ammunition, fuel and supply stores, directly in its rear. On the other hand, we find the attacking fleet far from these aids, and consequently, as is the case on land, it becomes necessary for this fleet, as a matter of principle, to proceed offensively if the surrounding conditions present any chances for success.

A separation of forces at sea is always subject to having any

small detached squadrons defeated in detail, therefore every effort should be made to keep the battle fleet as united as circumstances will permit, so that it can engage with full strength when entering battle, and not be exposed to defeat in detail. Sea warfare does not permit of conducting a delaying action, of engaging the forces in detail, or of detailing reserves, since it would be only inviting defeat to start the battle with a portion of the available forces and then try to engage the main body of the enemy at a decisive point in the action. At sea, therefore, superiority in numbers has a greater destructive effect than on land, since this is a question of a machine fighting a machine. This concentration of fire on a few ships, all other things being equal, will have every chance for success, because at sea the usual aids obtaining in land warfare, and which would help the weaker against the stronger, are sadly lacking. I refer to such matters as terrain, which presents cover from fire and from view, and which offers the opportunity for deceiving the enemy as to the direction and strength of the attack. At sea everybody has the same range of view hence all else being equal, superiority in numbers must lead to victory.

It must always be borne in mind that creating a fleet is a long and tedious process, as has been proven in some of our past wars, and it is beyond hope to expect the number of available fighting ships to be increased to any degree during the prosecution of the war, unless it should be of long duration. Thus the reluctance of the Grand Fleet and the High Sea Fleet entering into close action at Jutland. A lost ship is irretrievably gone, its replacement will require a year or more, and neither of the two felt they could well stand any great losses, although the losses they did sustain were certainly too heavy for the results obtained. This condition leads to a method of conducting a naval war by attempting to bring about an equalization of forces, and which might make it possible to fight under more favorable conditions when the decisive battle is to be fought. Here the coast defenses are of the greatest assistance, and in such case they gain in importance far beyond any idea of a pure measure of protection. They become a very active factor in naval warfare and the enemy is compelled to reckon with this active force.

THE enemy has two methods at his disposal to attempt fighting down the defender, viz., blockade and attack. Maintaining a blockade is, however, a condition which makes great demands on the blockader. Such service is exceedingly exhaustive, and this is even more so when the defender is in possession of a battle fleet which assumes an active part in the defense of the coast, and when the naval base of the blockader is far away. It is impossible for the blockading fleet to continually keep to the high seas, since in general it must confine itself to watching the hostile coast through the detachment of a number of ships, while the remaining bulk of the battle fleet is at a safe naval pivot behind the line of observation so as to be prepared to oppose any hostile action. If the fleet is unable to establish such pivots near by, it will be compelled to seize such locations in close proximity to the blockaded coast.

It is therefore necessary that the defender, if possible, turn these circumstances to his own advantage. He will occupy and if possible fortify, or at least be prepared obstinately to defend, all such points which the enemy might select as pivots. He must take advantage of every opportunity to keep the blockading fleet on the continuous alert by constant and, if possible, sudden attacks, preferably at night, by submarines or torpedo boats, or by the battle fleet itself. During such attacks he must inflict as many losses on the enemy as is possible, being careful to break off the action so soon as the enemy succeeds in bringing superior forces to bear on the attacker. If reconnaissance is successful there is no doubt that opportunities will be observed which will make a warranted attack on the enemy, or when the latter, for example, has weakened his forces at one place or another, productive of the desired results. The very nature of such a blockade necessitates a certain amount of division of forces, but the fleet acting on the defensive can always lie concentrated at safe anchorage and prepared to make a sortie at any favorable moment. The exertions required of the enemy are exceedingly great during such a blockade; his ships will be severely strained, and he will probably suffer heavy losses. Consequently it cannot be expected that he will, or even can, continue to confine himself to such an indecisive prosecution of the war and, sooner or later, he must decide to attack the coast defenses and mine fields to capture the defender's naval bases and to destroy his fleet.

This is not an easy matter to accomplish, and the assailant will certainly suffer heavy losses; so if a comprehensive survey, which is not possible in the space allowed me, of all the difficulties surrounding the assailant in his conductance of the blockade and final attack on a well-defended and fortified coast is made, it will no doubt show how comparatively favorable the conditions are under which such a war can be conducted by the defender. In such a situation it is possible to imagine that even a great superiority in ships will become depleted by attrition until an ultimate state of affairs will exist in which the original difference in forces will probably have been equalized; the moment will then have arrived for the defender to become the assailant. Such a moment requires the battle fleet, which hitherto was the defender, to put to sea and fight the decisive battle.

It is for these purposes, as well as for the destruction of enemy commerce, that we require a navy, but a great many of the duties here explained can be carried out with more effect by air forces. The naval air forces can destroy surface fleets by bombing; they can maintain a blockade without closely approaching the blockaded point and thus subject themselves to antiaircraft fire, because as "eyes in the air" they can spot oncoming vessels from afar and destroy them by bombing. They can protect the trade routes and lanes of communication; they can spot and destroy submarines; and, by a well-concerted attack, they can destroy ports, dockyards and coast cities, providing these are not properly protected against them, while escort convoys would also be at their mercy.

THE menace to these costly dreadnoughts, as well as to other ships, of the submarine and the seaplane is not a theory, but an actual fact, as witness the warning given the British Navy during the 1913 maneuvers, when an "enemy" submarine suddenly arrived unobserved among the fleet anchored in the Firth of Forth; she fired a dummy torpedo at the flagship, and the consternation created by this hit may be better imagined than explained. During the World War the British CRESSY, HOGUE and ABOUKIR within an hour were sunk by torpedoes fired from a German submarine carrying a crew of thirty men, while each of these armored

cruisers carried some eight hundred men, and three ships probably costing five million dollars each were thus utterly destroyed by an unseen pigmy which cost probably no more than half a million dollars. In consequence of this successful attack, the Grand Fleet quickly steamed out of the North Sea and sought refuge in Lough Swilly, hundreds of miles distant from the fighting area, and there it remained in safety, but not before losing the dreadnought Audacious on the way, having struck a mine in a mine-field laid by German submarines.

Commander J. M. Kenworthy, R. N., tells us ("New Wars: New Weapons") that "the Grand Fleet, the very symbol of the might of Britain, was literally off the map as regards the war. And there it stayed for many weeks, during which the war could have been won or lost finally in Europe, unable even to venture, for fear of torpedoes, away from the landlocked and distant Irish harbor where it had taken refuge. In the meantime defenses were being hurriedly erected at Scapa Flow, a great inland sea surrounded by the islands of the Orkney Group; merchant ships—old liners and passenger ships—were being purchased by the Admiralty and sunk in the wide entrances to block the passages between the islands to submarines; nets and booms laid down, batteries and searchlights established on shore. Finally the Grand Fleet was able to emerge from the Irish mists and take its station at Scapa Flow, where it remained until the defenses in the Firth of Forth had been completed."

All this was brought about by the firing of a few torpedoes from a German submarine and the exploding of a German mine, because dreadnoughts were too expensive to subject them to the danger of loss. The Germans, however, had the same fear, and religiously kept their High Sea Fleet in safe harbors, being in awe of French and British torpedo craft.

Two years later the Grand Fleet and the High Sea Fleet came together in the Battle of Jutland, where Admiral Jellicoe, acting under orders, refused close action either by day or night because he feared to lose his dreadnoughts, and in the end the High Sea Fleet made its escape through the superb strategy of Admiral von Scheer. Neither admiral desired to close on the other unless reasonably sure of an initial advantage. When the clash actually occurred the British brought 37 battleships and battle-cruisers of the dreadnought type against 27 of the Germans. The British carried 168 guns of 13.5- to 15-inch caliber and 104 of 12-inch, while the Germans could count only 176 guns of 12-inch caliber. The British also possessed superiority in cruisers and destroyers, or 8 armored and 26 light cruisers against 11 German light cruisers, and 80 destroyers against the 63 of the Germans.

It is reported the British lost three battle-cruisers, three armored cruisers and eight destroyers, a total tonnage of 114,000, with practically all the men on board. Germany lost one battleship, one battle-cruiser, four cruisers and several destroyers, her total loss being estimated at 60,720 tons. England claimed the Germans had lost in addition one super-dreadnought, four battle-cruisers, five destroyers and a submarine, which would have brought the German losses to more than 100,000 tons, but the super-dreadnought Hindenburg and the battle-cruisers Derflinger and Seydlitz, which the British claimed to have sunk, were surrendered at Scapa Flow after the Armistice, hence the British claim of having sunk some 100,000 tons could not have been a fact.

This was certainly a "Pyrrhic victory" for England, because her immense losses in both ships and men could hardly have been surpassed in defeat, but all neutral observers were inclined to agree that it was impossible for either side to claim a great victory, as had been announced by both contestants. The control of the sea, however, remained securely British, since the High Sea Fleet did not again offer battle.

From this it is quite obvious that the dreadnoughts and super-dreadnoughts, even in the narrow waters between the European mainland and England, played anything but a major role in deciding the Great War. On the other hand, the British losses were extremely heavy from German submarine attacks on merchant shipping, and had Germany employed these undersea boats with the same vigor earlier in the war, the final result might have been quite different. As it was, England was brought almost to ruin by lack of food supplies and raw or finished materials through the submarine campaign. Had these same German submarines been employed at an earlier date against the Fleet with the same determination as was exercised against merchant shipping, they would undoubtedly have created havoc in the Grand Fleet by surprise attacks, and would thus in a few weeks have obliterated England's naval superiority.

The submarine was finally answered by the advent of the sub-chasers and destroyers, and eventually by the airplane, but while England badly needed destroyers and cruisers for the protection of her sea routes against Germany disguised raiders, the Grand Fleet required some 100 of the former and 60 of the latter to act as screens against the submarine menace whenever this grand naval parade left the safety of Scapa Flow, thus withdrawing them from a sorely needed service in order to nurse $50,000,000 vessels which were useless as fighting ships after Jutland.

THE question now naturally arises as to whether these huge floating fortresses will be of any practical value in future wars. The example quoted above, or where both the British and the Germans hesitated to throw them into the uncertain chances of battle, certainly seems to give a negative answer, since even with only narrow seas confronting them, with bases near by, neither nation had the satisfaction of seeing their battle fleet, on which countless treasure had been expended, contribute anything towards winning the war.

Isolated as are the United States, or separated from other lands by wide oceans, it is highly questionable in view of the above facts whether any enemy battle fleet will ever approach within striking distance of our shores, nor will we freely venture our dreadnoughts in an approach to hostile shores, thousands of miles away, without great qualms of misgiving.

Cruisers are certainly still needed to control our trade routes, but even in this case it is questionable whether the type in use at present will prevail at some future date; in view of the success attained by the submarine it is highly probable that the cruiser of the future will be of the submersible type. Only England, of the foreign Powers, still persists in building battleships, all the other countries concentrating on cruisers, and principally submarines. France possesses a submarine fleet of fifty-three vessels and at present is building forty-nine more, the latter being larger and faster than any of the older types, and these are intended principally for employment against merchant shipping, or for the

purpose of preventing supplies reaching her foe's shores. To combat this menace does not require battleships, as witness the fact that during the Great War the German submarines sank 11,154,000 tons of Allied shipping, and for months this sinking cost from eleven to fifteen million dollars a day in the value of ships and cargoes. During this period it is estimated they never had more than some thirty submarines at sea at any one time, and these, besides the damage done to Allied shipping, practically destroyed the Spanish and Norwegian merchant fleets because they were carrying supplies to the Allies.

According to the idea prevailing in the German mind, a sinking of 600,000 tons of Allied shipping a month for a period of one year would win the war. This almost succeeded, and for a time the sinking amounted to 850,000 tons a month. Did the battleship or armored-cruiser assist in destroying this menace? It did not, but dependence was placed on some 4,000 patrol boats, mine sweepers, motor launches, destroyers and convoy cruisers, and the efforts of these vessels were greatly aided by the laying of a vast mine field across the North Sea, from Scotland to Norway, and these latter efforts just succeeded in warding-off final defeat through the stoppage of sea communications.

It does not require any great stretch of the imagination to recognize the obvious in this fact; that the huge floating castles played but a sorry part during the entire war period. Nor did the light cruisers attached to the Grand Fleet play any more important role in this grim struggle, since they could not attack submarines, but the latter could and did sink the former. It is a well-known fact that the smaller and faster the ship, the less is her danger in a submarine attack, and this was again proved in the case of the destroyers, since the latter were the principal antagonists of the under-sea boats.

The submarine, like the tank, has met its answer. It does not require any vast effort to destroy this slow and blind undersea boat, especially when she comes to the surface. The answer when she is submerged lies in the acoustic and electrical devices developed for locating her, so that she can be attacked by depth charges, or under-water bombs, arranged to explode at a predetermined depth below the surface.

So much for the submarine menace, and about which much more could be said, but we must now look to the new naval menace confronting ships at sea, that is the menace from the air. It is a much greater danger than that experienced during the recent war, and this menace from the air must also be included in the answer to the submarine, for under certain conditions the latter can be detected floating below the surface of the sea by the observer in the plane, after which a well-directed bomb dropped from the skies will spell doom for the U-boat.

THAT the air is a supreme menace to shipping is obvious from what occurred during the Great War, as well as since then. Only two of the war examples need be mentioned here. The sinking of a collier by a Zeppelin and the capture of a ship by another. In the first case, the collier had sailed from Hartlepool on her way to Cowes but, due to danger from mines, she anchored for the night inside a sandbank known as the Kentish Knock, where she found several other ships seeking shelter. The German Zeppelin, on her way home from a raid, spied these ships lying at anchor, and dropped a bomb alongside the collier. The effect of the explosion, confined by the water, was so great that the collier's hull was staved in, and the ship sank so quickly that it was even impossible to lower a life boat before she disappeared beneath the surface. In the other case, a Zeppelin cruising over the North Sea spied a merchant vessel near the coast; a small bomb was dropped ahead of the ship, causing the latter to stop; the Zeppelin lowered a collapsible boat, placed a prize crew aboard the ship, and escorted her into a German port.

As to what has happened since the war, we need not refer again to the abortive attempt to bomb the MOUNT SHASTA, the reason for which I cannot explain to my own satisfaction, much less to that of others. Rather recall the bombing experiments of 1921 when, after the Washington Conference, a number of ships were condemned to be scrapped. In addition to several of our own ships we had a number of German vessels for targets, vessels which had been surrendered to us after the Armistice. The first one to meet its fate from the air was the German submarine U-117. She was attacked by three planes each supplied with three 180-lb. bombs. One discharge cut the hull in two and she sank. This was followed by a German destroyer; the bombs churned the water in every direction as they fell all around the vessel; one struck the middle of her deck and she suddenly broke in two and sank. One 600-lb. bomb was sufficient to sink the cruiser FRANKFORT.

Next came the super-dreadnought OSTFRIESLAND, a vessel which had been designed especially to resist an underwater attack by mines and torpedoes. The Germans had boasted of her as being unsinkable. In ten minutes after four 2,000-lb. bombs had been dropped in the sea alongside her she went to the bottom. Our own battleship VIRGINIA was the next to succumb, and a minute after a concentrated attack had been launched on her she was a mass of twisted iron, this effect having been accomplished by dropping a number of small bombs on to her deck, while one 1,100-lb. bomb, dropped in the sea at her side, put on the finishing touch, and she disappeared from sight. The more modern battleship NEW JERSEY was hit by one 1,100-lb. bomb; she turned turtle and went down, and our Joint Board, in the report it made to Congress, said "it will be difficult, if not impossible, to build any type of vessel of sufficient strength to withstand the destructive force that can be obtained with the largest bombs that airplanes may be able to carry."

It is true that these ships were stationary and were unable to put up any defense, an almost impossible case during war, but on the other hand the planes were few in number, while during war the attack would probably be made by hundreds of planes.

It is obvious from the above citations that a direct hit is not necessary to cause irreparable damage, since dropping a bomb in the sea near the ship, where its exploding effect is confined by the water, is just as dangerous, or even more so, because the explosion drives in the side plating and the ship is doomed. If this is possible in the case of battleships, how much more dangerous is this menace to merchant vessels!

(*To be continued in the July-August issue of this Journal.*)

The Index to ARMY ORDNANCE, Volume XII, which concludes with this number, is now in preparation. It is arranged by subject and author alphabetically and includes title page for binding. Copies of the Index will be furnished without cost upon application to the Editorial Office.

Shades of Russia's Cossacks

A Soviet Cavalryman and His Mount Both Equipped with Gas Masks.

Russian Officials Review Mounted Machine Gunners—The Four Horses of Each Unit Handled by One Trooper.

The Stability of Smokeless Powder

Observations on Methods and Results of Testing Nitrocellulose

By G. C. Hale*

EVER since the introduction of smokeless powders in military and sporting ammunition the stability of the nitrocellulose or cellulose nitrate used as a base for these powders has been a subject of practical interest to both the manufacturer and consumer and of theoretical as well as practical interest to the explosives chemist.

During recent years the uses of cellulose nitrate have been greatly extended and a considerable quantity is employed annually in compounding lacquers, artificial leather and films of various kinds; this has led to a more widespread interest in the properties of the series of compounds referred to as cellulose nitrate. The literature of chemistry, and of explosives in particular, contains many references to experimental work having for its object a clarification of the factors which control the stability of cellulose nitrate and of smokeless powders prepared from it. Under this general subject the specific problem of establishing a generally satisfactory method of determining the stability of the nitrate and smokeless powder has been treated at considerable length. There are about twelve methods which have been developed, employed to some extent either in this country or abroad and each recommended as having advantages over some of the others from one viewpoint or another. A review of this bulky literature leaves the impression that in many instances a change has been mistaken for an improvement, i. e., the author of an improved test has devised a different method of measuring stability but obtains results no more comprehensive than those given by other tests when applied generally. This distinct impression contributed by the existing literature is responsible for this present effort to present some further observations on the subject.

The term stability as commonly applied to cellulose nitrate, smokeless powder and other explosives refers to the capacity of the explosive to retain its chemical and physical properties without change under the normal conditions of storage. If an explosive undergoes no measurable decomposition when stored at atmospheric temperatures but unexposed to the elements for many years, it is considered in a qualitative sense to have good stability. If appreciable decomposition occurs under similar conditions within a few years the explosive is classed as one having low stability. To obtain advanced information on the stability of any new explosive of unknown properties or of a recently manufactured lot of any standard explosive, it is customary to conduct a test at an elevated temperature so as to hasten decomposition and thus make possible an immediate comparison of the resistance of the explosive in question with that of a standard, the behavior of which under prolonged storage is well known.

It is often found in attempting to determine the stability of cellulose nitrate or smokeless powder by employing tests at elevated temperatures that if samples carefully selected from several different lots are subjected to a number of the tests in common use, the results do not agree in indicating the relative stability of the different lots; this is particularly true if the different tests are conducted at different temperatures. This situation has produced much discussion in which the author of one test contends that the indications of his test are more reliable than those of the others. In considering the relative merits of the tests which have been proposed and used to measure stability it is necessary to take into account the principal factors which affect the rate at which cellulose nitrate decomposes.

ALL organic compounds and in fact almost all compounds known can be decomposed by heat alone. The minimum temperature at which decomposition occurs with sufficient rapidity to be measured, varies widely indeed among the various compounds but this difference is merely one of degree since none is entirely proof against the effect of heat. Explosives in general fall in the range of chemical compounds which are affected by only moderately elevated temperatures, there being very few which will withstand a temperature as high as 200° C. for any appreciable length of time without undergoing decomposition. There are also many nonexplosive compounds which decompose fairly rapidly at slightly elevated temperatures, some of the sugars for example not being appreciably more resistant than the more stable explosives such as TNT. Lactose or milk sugar undergoes rapid decomposition above 150° C.

The resistance of a chemical compound to decomposition by heat is an inherent property or characteristic dependent upon the structure of the molecule as is the color, the melting point, or the odor. Since no two compounds have precisely the same melting point, boiling point and other physical properties it is to be expected that no two compounds would behave in precisely the same way as regards their resistance to heat. It would be entirely practicable to determine by experiment the rate at which any given compound decomposes at various temperatures and obtain a temperature-decomposition curve which would be definitely characteristic of the compound. This in effect has been done for cellulose nitrate, smokeless powder and most of the prominent explosives and it has been found that the difference in their behavior is sufficiently great to be of much significance from a practical viewpoint. Some explosives show practically no decomposition at atmospheric temperatures or at temperatures as high as 75° C. or even 100° C., while others although fairly resistant at atmospheric temperatures will undergo rapid decomposition at the higher temperatures mentioned.

Cellulose nitrate is one of the least resistant explosives used in our military ammunition; since the stability of smokeless powder is determined by the stability of the cellulose nitrate in it, the powder itself consequently has relatively low resistance to heat.

Fig. 1 is a curve established by plotting the time required for spontaneous explosion or ignition of a small sample of the standard smokeless powder against various temperatures to which the powder was exposed.

From the slope of the curve it is indicated that as the

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temperature is reduced the time required for ignition is greatly increased within and below the lower range of temperatures used. If temperatures considerably below those given in the curve are used in the test it is found that spontaneous ignition of the sample does not occur since the rate of decomposition is so low that radiation of the heat

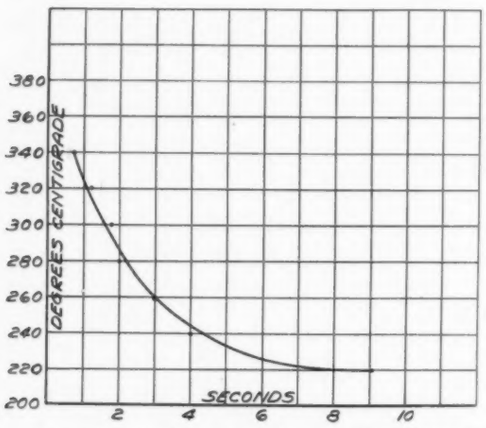

Fig. 1. Time Required for Ignition of Smokeless Powder at Different Temperatures.

liberated in the reactions, prevents elevation of the temperature to the ignition point; which holds true even though the decomposition is allowed to proceed until the powder is rendered substantially inert. This requires that some index other than spontaneous ignition be used to determine the effect of any given low temperature in promoting decomposition.

Some of the stability tests applied to cellulose nitrate are conducted at a temperature as low as 65° C. while others employ higher temperatures, 135° C. being about the highest used in any of the more prominent tests. An index to the degree of stability possessed by the sample is given in some of the tests by the time required for measurable decomposition to occur. The end point or measure of decomposition may be obtained in various ways, e. g., by noting the change in the color of a test paper exposed to the gases evolved upon decomposition; by collecting the gases evolved and measuring the volume quantitatively; by collecting the gases in water and determining the degree of acidity developed in the solution, etc. It is not the intention to discuss the relative merits of these methods of establishing the end point or measure of decomposition in such tests; the general nature of the methods is referred to in order to assist in the further discussion.

If the tests employing different temperatures and different means for determining the degree of decomposition produced by the elevated temperatures are applied to cellulose nitrate of high purity, i. e., practically free from moisture, acids, or other extraneous material, concordant results will normally be obtained, assuming that the test procedures have been properly standardized and conducted. But wide discrepancies are often noted in conducting the various tests on incompletely purified cellulose nitrate or on smokeless powders which were manufactured from such cellulose nitrate or which have undergone some deterioration due to age. From a practical standpoint it is often urgently desired to determine by test the degree of stability possessed by an old powder which is expected to have undergone some deterioration and yet it is in testing such samples that the various methods show the greatest divergences in indicating the condition of stability. The cause for such discrepancies lies in the fact that other factors besides temperature are involved in promoting decomposition of the cellulose nitrate in the stability tests.

ANY chemical compound can be decomposed by reaction with certain other compounds. The reactivity of compounds varies widely as does their resistance to decomposition by heat alone. Cellulose nitrate being an organic salt or ester exhibits to a certain degree the characteristic reactivity of esters in general. Most esters can be decomposed by boiling water, this decomposition being accelerated if either acid or alkali is also present. While there are of course many other compounds besides water, acids and alkalies which will effect decomposition of cellulose nitrate, it is of no importance to mention them specifically in this discussion. The reactivity of the nitrate with water, acids and alkalies is, however, of particular importance because of the use of these compounds in the process of manufacture and the difficulty with which they are eliminated completely in the purification of the nitrate. Some moisture and acidity are present in nearly all lots of cellulose nitrate used in the manufacture of smokeless powder and their presence reduces the stability of the powder and complicates the interpretation of the results from any stability tests which may be made on the powders from time to time during their existence in ammunition or in bulk storage. The effect of acidity on the stability of cellulose nitrate, as indicated by two of the standard tests, is shown in Table I. These data were obtained on samples of the nitrate (12.6 per cent nitrogen)

TABLE I.

Sample No.	Acidity of Cellulose Nitrate Calculated as Sulphuric Acid	KI Test at 65.5°C*	135°C Heat Test	
			Time Required for Change in Color of Methyl Violet Test Paper	Time Required for Appearance of Red Fumes
1	0.11 per cent	2 mins.	5 mins.	5 mins.
2	0.09 "	3 "	10 "	10 "
3	0.071 "	7 "	10 "	10 "
4	0.057 "	18 "	15 "	15 "
5	0.049 "	40 "	25 "	30 "
6	0.042 "	43 "	30 "	40 "
7	0.037 "	49 "	30 "	40 "
8	0.032 "	60+ "	35 "	50 "
9	0.022 "	60+ "	35 "	50 "

*The data given represent the time required for faint discoloration of the potassium iodide starch paper used as the indicator in this test.

removed for test at successive intervals during the purification process which consisted in alternate digestions with boiling water and washes with cold water. The free acidity of the nitrate was determined by dissolving the nitrate in acetone, precipitating with water and titrating the acetone water suspension. Since the work was done it has been found that this method for determining acidity gives results in general about .02 per cent too high; the values given hence may be in error to this extent but this is not of major importance here since the relative effect of acidity is the point it is desired to cover. The heat tests were conducted according to the standard Ordnance Department procedures. The data given are representative of those obtained in a number of purification experiments, insofar as the relation between the acid content and stability of the nitrate is con-

cerned, although the exact figures given for the heat tests were not duplicated for each acid content in the various experiments. It was uniformly true however that no KI test above 35 minutes, which is the minimum time allowed by the Ordnance Department specification, was obtained when the acid content was above 0.06 per cent. Conversely KI tests above 35 minutes were obtained with regularity (although not invariably) when the acid content of the nitrate was reduced below 0.05 per cent.

It is desired to point out particularly that in the above experiments Sample No. 5 complied with the specification minimum of 35 minutes for the KI test while it failed to pass the minimum requirement for the 135° C. heat test, viz., 30 minutes. It is often found in testing cellulose nitrate that a sample of one lot will comply with the requirements of the 65° C. KI test but not the 135° C. heat test while a sample from another lot will comply with the 135° C. heat test but not the KI test.

THE general effect of moisture in promoting decomposition of smokeless powder composed essentially of cellulose nitrate has long been known but as there is little specific information on this point in the literature, tests were conducted at Picatinny Arsenal in order to provide specific data of practical value. Samples of four lots of the standard smokeless powder having the same grain dimensions and all of excellent stability were placed in a dry atmosphere in hermetically sealed containers and in humidors in which a saturated atmosphere was maintained; they were then exposed continuously to a temperature of 50° C. in a surveillance magazine. Small portions of the samples under test were removed at intervals and subjected to the 135° C. heat test. The difference in the behavior of the samples stored under dry and moist atmospheres was striking as is shown by the summary of results in Table II. The data represent in each case the time required for the sample in the heat test to evolve sufficient fumes to produce a complete discoloration of the normal methyl violet test paper.

TABLE II.

Sample No.	1		2		3		4	
Storage Condition	Humid	Dry	Humid	Dry	Humid	Dry	Humid	Dry
	mins.	mins.	mins.	mins.	mins.	mins.	mins.	mins
135°C Test—Original	105	105	110	110	120	120	105	105
" " after 3 mos	80	140	90	90	70	120	85	95
" " " 5 "	**	**	10	**	15	**	60	**
" " " 6 "	80	105	.....	90	.....	130	10	105
" " " 8 "	5	**	.....	**	.....	**	.....	**
" " " 9 "	.....	100	.....	85	.....	130	.....	105
" " " 24 "	.....	105	.....	85	.....	120	.....	105
" " " 36 "	.....	90	.....	105	.....	.....	.....	.....
" " " 48 "	.....	95	.....	105	.....	.....	.....	.....

**Signifies that test was not made at the time indicated.

It is shown that samples 2 and 3 developed extreme instability after storage for only 5 months under a saturated atmosphere; sample 4 withstood this condition 6 months and sample 1, 8 months. The tests were discontinued of necessity on samples 3 and 4 after 24 months exposure to the dry atmosphere although they had at the time not shown any evidence of deterioration. Samples 1 and 2 under dry atmosphere have shown no marked drop in stability even after 4 years; these samples are still under test.

Additional tests of this nature have been conducted on powders made from cellulose nitrate and various percentages of a nonvolatile nitroaromatic colloiding agent which tends to render the powder nonhygroscopic. It has been shown that the resistance of these powders to a humid atmosphere at 50° C. varies directly with the per cent of nonvolatile colloiding agent present, i. e., the degree to which the hygroscopicity of the powder is reduced. With 2 per cent of the colloiding agent the powder remained under test for 10.5 months; with 5 per cent, 28.5 months; and with 7.5 per cent, 40.8 months. Presumably if sufficient colloiding agent could be used to render a powder entirely nonhygroscopic the powder would show the same stability under exposure to a saturated atmosphere that it would under a dry atmosphere. The above data constitute a strong argument for nonhygroscopic powders from the standpoint of stability, since the effect of moisture in promoting decomposition is extreme when the powder is subjected to only slightly elevated temperature.

SUFFICIENT data have been given to show definitely that in determining the stability of cellulose nitrate or smokeless powder we are dealing with the inherent stability of cellulose nitrate, i. e., its resistance as a compound to decomposition by heat alone and in addition the reactivity of the nitrate with various possible impurities. While data have been given only on the effect of moisture and acidity it is not to be inferred that these are the only impurities to contend with. The effects of these have been cited as examples of the reactivity of cellulose nitrate.

It is recognized that the velocity of different chemical reactions is by no means the same at a given temperature. The oxidation of carbon at room temperature is so slow that the rate cannot be measured while the reaction between sodium chloride and silver nitrate in water solution is so rapid that it cannot be, or at least has not been measured. The variation then in the rate of reactions at room temperature or at higher temperatures for that matter is enormous—from almost zero to perhaps the velocity of light.

It is commonly stated in text books on physical chemistry that the velocity of a reaction is increased 2 to 3 times for each 10° C. increase in temperature. This does not hold invariably but the temperature coefficient can be said rightly to be of this order of magnitude for most of the reactions that have been measured. Hence as temperature increases in arithmetical progression, velocity increases in geometric progression. In order to emphasize the relation here, assume that the velocity of a given reaction is trebled for each 10° rise and that the velocity at 0° C. is one. The velocity will be 3 at 10° C., 9 at 20° C., 27 at 30° C., 59,049 at 100° C. and 1,000,000 at 126° C.

Now, if the reaction between cellulose nitrate and one impurity has one rate of reaction at say 20° C. and the reaction between the nitrate and another impurity has another rate at the same temperature, it is obvious that if the relation above cited is only approximately correct, increasing the temperature to 65° C. may produce considerable decomposition as a result of one reaction but only very slight decomposition due to the other. But if the temperature is raised to 135° C. appreciable decomposition may result from both reactions. It is possible then to have two samples of cellulose nitrate or of smokeless powder both of which are relatively unstable at an elevated temperature, e. g., 135° C. but which, because of different impurities being responsible for the instability, will not exhibit the same relative stability when exposed to temperatures lower than 135° C.

(Continued on page 430)

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Month by Month

Automotive Vehicles in War

WE have been featuring articles on automotive vehicles for some time past and hope to continue to do so. With the enormous armies of today and their tremendous consumption of munitions of war a question always present in the mind of the supply officer is where sources of production may be found. The following is a brief discussion of some of the aspects of production and supply of certain automotive vehicles which are extremely important in war. The principal of these are the aircraft, the automobile, the truck, the tractor and the tank.

The automobile, the truck and the tractor are purely commercial developments and our incomparable automotive designers and manufacturers have led the world in quantity and quality of product. Practically every military need for automobiles, trucks and tractors can be met by the current designs and output of our factories and should be so met. It is not too much to say that when a commercial product fairly fills a military need it would be almost criminal to require a special design for military uses. Also the rapid progress in design and manufacture which has been made in the past gives us such assurance as may be had that we shall keep abreast of future developments.

In this connection a recent public demonstration of a truck-towed battery of light field guns is in point. The unit represents a complete severance from the principle of special type vehicles and from vehicles requiring extensive alterations for military use. Every transport battery of the unit is a standard product. There is sound logic in this philosophy of munitions supply which the Ordnance Department and civilian engineers identified with it have preached since the World War. And it is a fundamental policy. May the day soon come when our military organization is furnished no special equipment at all in those cases where a commercial product, as it is or with minor modifications, will do the job.

The aircraft is probably the greatest twentieth century contribution to the implements of war. Fortunately the aircraft promises to be as useful to the peaceful pursuits of the nation as to its armies and navies in time of war; consequently the development of the ships of the air has been along both commercial and military lines. The special needs of the Army and Navy for planes of the pursuit and attack type have no counterpart in the demands for various types of commercial planes. On the other hand, cargo and passenger planes of commercial types may well be extremely useful in war. The combined commercial and military value of aircraft have worked together to accelerate the development of aircraft of all kinds so that the model of yesterday is often obsolete today. Up to the present time the military demands have contributed most to the building up of an aircraft industry but the commercial demand is substantial and growing and there is reason for confidence that our aircraft industry is firmly established. The existence of such an industry operating on a sound basis is of inestimable value to the nation as a war-time asset.

The tank is a purely military vehicle which was born of a sorely felt military need. Before the World War was a year old it was realized that the machine gun and the magazine rifle had greatly increased the power of the defense. With trenches provided with concrete pill boxes and dugouts it was found exceedingly hard to blast out the machine gunners and riflemen by artillery fire or aircraft bombing. The result was that when attack followed bombardment the defenders would leave their hiding places in the dugouts, reman the trenches and pour a destructive machine gun and rifle fire upon the attackers. The tank was devised and armor plated to give protection to its crew so that it could advance in the face of the severest machine gun and rifle fire.

As stated above, the tank is a purely military vehicle and has no commercial application whatever, hence it is exceedingly improbable that we shall ever have a tank industry in the sense that we have an aircraft industry or an automotive industry. This condition, of course, has had and will continue to have a serious effect on the development of the tank. Each year sees its new models of motors, trucks, tractors and aircraft of various kinds, not from a single manufacturer but from numbers of manufacturers of each class of vehicle. There is strong competition which insures rapid advance. The vehicles of today are the results of the experience had in the building and using of the thousands and millions during the past.

In this country the United States Government is the only customer to whom a tank can be sold, and during peace time only a limited demand can be expected. It necessarily follows that the cycle of design, test and redesign, etc., will be more or less long drawn out. However, the War Department is alive to the importance of the tank, and in addition to its own work important contributions have been made by Mr. J. W. Christie and his company, the U. S. Wheel Track Layer Corporation, and the Cunningham Company.

In foreign countries, particularly those countries which encourage their industrial concerns to enter foreign markets, something like an industry may be built up even in purely military implements of war. Such concerns as Vickers-Armstrongs of England, the Krupp Company of Germany and the Schneider Company of France, were of inestimable value to their respective nations during the World War.

It is unfortunate that we do not have a commercial source of supply such as exists for motors, trucks, tractors and aircraft, but our splendid automotive engineers and manufacturers can be depended upon to solve the problem of production provided they are promptly supplied with drawings and specifications of approved and accepted designs.

Popularizing the National Budget

AMONG the good things to come out of our present business difficulties undoubtedly will be an increase of visceral valor on the part of the man in the street. Necessity is forcing enlightenment and action on the part of many people who formerly considered public enterprise little, if any, of their business. Many were content to pay an income tax levy with slight further concern particularly about the mounting cost of government. That condition is changing and it is well that it is. Government, in its necessary functions and even in its extraneous operations, is the concern of all the people and the quicker they take hold even as they would their own private business enterprises the sooner will governmental expenditures reflect sane and sound judgment. On the score of adequate national defense there is nothing to fear and much to gain when expenditures are scrutinized by the taxpayer while certain functions which have little warrant in our government structure will fade before the white light of knowledge and sound thought. In other words, it will be a step of marked progress when our people as a whole familiarize themselves with the why and wherefore of our public expenditures.

These thoughts are occasioned by a recent letter of Mr. Lammot duPont, president of E. I. duPont de Nemours & Co., to stockholders in which the following comparative table of governmental expenditures appears:

(Figures to nearest hundred thousands)	1927	1932	Amount of Increase	Per Cent Increase
TOTAL EXPENDITURES	$3,493,600,000	$4,482,200,000	$ 988,600,000	28%
Less—Interest and Sinking Fund Payments (Statutory)	1,120,500,000	1,016,800,000	103,700,000*	9*
Less—Miscellaneous—Not included in Budgets of major departments	409,100,000	270,300,000	138,800,000*	34*
BALANCE—which was expended by major departments, commissions, etc., as follows:	$1,964,000,000	$3,195,100,000	$1,231,100,000	63%
Department of Agriculture	$ 156,300,000	$ 333,500,000	$ 177,200,000	113
Agricultural Marketing Fund—net (Farm Board)	.....	155,000,000	155,000,000	.....
Post Office Deficit	27,300,000	195,000,000	167,700,000	614
Treasury Department	151,600,000	312,900,000	161,300,000	106
War Department	360,800,000	483,700,000	122,900,000	34
Navy Department	318,900,000	378,900,000	60,000,000	19
Shipping Board	19,000,000	60,800,000	41,800,000	220
Department of Justice	24,800,000	53,800,000	29,000,000	117
Department of Commerce	30,900,000	54,700,000	23,800,000	77
Other independent offices and Commissions	35,400,000	57,600,000	22,200,000	63
Legislative Establishment	19,700,000	32,400,000	12,700,000	64
Department of Labor	9,900,000	14,100,000	4,200,000	42
Adjusted Service Certificate Fund	115,200,000	200,000,000	84,800,000	74
Veterans' Bureau (Veterans' Administration since 1930)	391,500,000	784,400,000	392,900,000(A)	100
Interior Department	302,700,000	78,300,000	224,400,000(A)*	74*
TOTAL OF MAJOR DEPARTMENTS, COMMISSIONS, ETC.	$1,964,000,000	$3,195,100,000	$1,231,100,000	63%

*Indicates decrease

(A)—Since the Bureau of Pensions was transferred from the Interior Department to the Veterans' Bureau in 1931, in order to make a fair comparison with 1927 it is necessary to combine the expenditures of the Interior Department and the Veterans' Bureau for each period, which results in an increase in expenditures in those two divisions of $168,500,000 for 1932 as compared with 1927.

Several other companies have sent out similar data. The annual budget of expenditures of the Federal Government is full of detailed information concerning the financial operations of the government machine. We have often wondered why corporations, large and small, have not had their expert accountants make detailed analyses of the budget.

In our judgment a general dissemination of information of this sort is a splendid thing because it gives the average individual a picture of conditions for which he is the final arbiter. Surprisingly enough Mr. duPont's analysis reveals that the defense services are chargeable with the lowest percentage increases of all governmental activities. But to call attention to this is not our purpose here. Neither do we debate the proposal advanced by Mr. David Lawrence in a recent broadcast and substantiated by Col. J. Clawson Roop, Director of the Budget, that 1932 appropriations represent purposely swollen expenditures to stem the tide of depression. Both points may be well taken. The fact remains that Mr. duPont's analysis offers introspection for all of us because ours is government by the people. An awakened and sustained interest in its costs can be productive only of good—good in that necessaries like national defense will be accorded full faith and credit but not so good for paternalistic parasites that deserve neither faith nor credit nor even existence.

The Collins Thesis on National Defense

IN presenting the much discussed Army Bill to the House of Representatives, Congressman Ross A. Collins, of Mississippi, Chairman of the War Department Subcommittee of the Appropriations Committee, prefaced his drastic proposals with a plea for modernization of our military equipment. The philosophy of mechanization was presented in striking, if not exactly correct tactical or strategic, form. We congratulate the Congressman on his analysis although the congratulation is proferred with reservations. He would move matériel one rung up the ladder to equality with personnel. In itself that is an ascendancy which industrial preparedness advocates have urged for years.

It is one thing, however, to plead for modernization of equipment and quite something else to do so at the cost of an unwarranted tampering with the National Defense Act on matters of officer personnel, the reserve component, the R. O. T. C., and the C. M. T. C. As to these essential factors of our system, the Collins proposals are not only more drastic than even the needs of rigid federal economy demand—they are aimed at the very essence of the National Defense Act. That Act, which is the most logical, effective and non-militaristic plan yet devised for the military defense of the United States and its possessions, is not a haphazard law. It was born of trial and error and represents the best thought and experience of our civilian and military leaders. It epitomizes the failures and accomplishments of all our wars—especially the World War—and it gathers into one definite directive the basic needs of our military machine. It has stood the test of more than fifteen years of analysis and application and is adjudged by its sponsors and its propo-

nents the best vehicle for inexpensive and efficient preparedness. As great as the demands of economy are at the moment, he who would attack the frugal provisions of the Act by aiming a death blow at its vitals must accept entire responsibility for the ravages of our unpreparedness in another emergency.

Followers of the Collins doctrine are sincere. In line with its policy of open discussion Army Ordnance publishes elsewhere in this issue an analysis of the situation entitled "Economy and the Army" by Hoffman Nickerson whose perception of things military and whose knowledge of defense history place him, in our judgment, among the few outstanding military historians of our day. Although the Nickerson text was prepared prior to the introduction of the Army Bill, the author arrives at conclusions which are in some respects strikingly akin to the Collins doctrine. Both can be said to present a viewpoint of immediate popular appeal—popular because the public must dig deeper than ever to pay the piper and is insisting that every penny for federal functions be wisely spent. Hence the choice is between spending our fewer pennies more wisely while maintaining the provisions of the National Defense Act, or knifing the Act by drastic curtailment of essential operations.

Take for instance the minimum number of regular officers required to execute our ramified military pursuits. Most certainly General MacArthur, Chief of Staff, and the War Department are in the better position to determine our needs in this respect and their viewpoint should govern. Likewise, as to the civilian components, the National Guard, the Reserve Officers' Training Corps, the Officers Reserve and the Civilian Military Training Camps. While all will grant the necessity for some temporary retrenchment of expenditures in this day of empty tils, no one will concede that it should be other than temporary. The Defense Act, and that means our whole military defense, rests on the ample continuation of these functions. Tampering with essential provisions of the Act which aims to give us a ready defense with a nucleus of professional soldiers and a trained reservoir of citizen reserves is dangerous business and false economy especially at a time of domestic and world-wide unrest. Hence the Collins thesis is commendable as far as its plea for modernization of defense goes. But since the major theme would whittle away basic personnel provisions it would be a serious blow at our already meager defense set-up. Such doctrine cannot be accepted now as anything other than a definite attack upon the National Defense Act.

Reserve Training at the Cross-Roads

THE recent strenuous assault on the training of reserve officers must cause observers much concern for it is a situation of serious consequences. Serious because reserve training is the very life-blood of our great citizen army. Should the means of keeping in constant readiness through the limited study, which the already too infrequent training periods afford, be jeopardized, then the entire system is endangered. That system, we submit, is basic. If trained officer personnel is lacking in another emergency, then we must face again the delays and misfits of our World War experience. If leadership is not developed now at some relatively little cost it must be provided later on at great cost. If, as we have reiterated time and time again, the National Defense Act is to be attacked by doing away now with the very things which past experience proved so necessary, then at least let opponents of national defense not pose under false colors.

The statement of the case for our Reserve Corps has been made frequently enough. Apparently it has missed its mark in some quarters. The case is clearcut, however. First, either the National Defense Act which places prime importance on the reserve is correct in so doing or it is not. We maintain that it is correct. Second, the reserve to be of any value must be trained to the extent which the federal treasury will permit or it can be allowed to die of malnutrition. We contend that a reserve worthy of the name must be trained to the highest possible degree. Third, the cost of reserve training is an unnecessary expenditure and should give way immediately in time of depression, or it is a wise expenditure the value of which is not to be measured in immediate return and the small cost should be considered as a logical price of real preparedness against war. We contend that it is most certainly the latter.

Efforts to curtail reserve training to the point of actual annulment of this phase of the National Defense Act place the whole theory of a reserve of officer personnel at the crossroads. One way leads to a paper organization of individuals no more familiar with their war-time assignments than the beginner in arithmetic is familiar with the pitfalls of quadratic equations. The other, the thus far accepted, way leads to what General Pershing had in mind when the World War was over—a *cadre* of regularly trained men ready to assume their jobs when the call comes and to assume them with assurance to themselves and their fellow citizens that they are properly trained to undertake the job in hand.

War is Sub-Division—Not Concentration

GEN. PEYTON C. MARCH, Chief of Staff of the Army during the World War, expressed in a phrase the entire principle upon which rests the reason why the Army and Navy should not be consolidated into one department of national defense. Speaking on this subject to the members of the Washington Post, Army Ordnance Association, at their spring meeting recently, General March said that victory in war being paramount, the goal is won by division and sub-division of effort and not by concentration.

Application of the principle to actual conditions proves its soundness. On battlefield and in factory success narrows down to efficiency of small units. In munitions operations, as an example, efficient results were not obtained in the nation-wide organization until each complex problem was broken down to its smallest factors. Recall that field artillery ammunition was a real problem in the World War. It was solved not by grouping together under one head every activity but by splitting down each component until there was one unit responsible for each particular function. The same logic applies with equal force to the organization in the field. General March is among the best qualified to express an opinion on the subject and he has done so with incontrovertible clearness. Any change which would further concentrate would to that degree endanger victory and our defense services on land, on sea and in the air, exist for only one purpose—to win in war.

Weapons and Security

An Editorial

THE following quotation is taken from the address of Ambassador Gibson April 11th to the General Disarmament Conference at Geneva. Ambassador Gibson was discussing the causes of the feeling of security or insecurity among nations:

"I repeat, the feeling of insecurity rests on fear of invasion. Fear of invasion is based on the existence of peculiarly aggressive weapons in land warfare—tanks, heavy mobile artillery and the use of gas. The feeling of security will not be restored until we restore to defense the superiority over aggression which it enjoyed in former times. The only way to restore such superiority is to do away with the weapons which I have just mentioned."

Ambassador Gibson's statement turns one's mind at once to the past when no such things as tanks, poison gas and mobile heavy artillery existed: for instance the Franco-Prussian War. At that time the tank was unknown and nobody dreamed of using poison gas as a weapon. By the term "heavy artillery" it is assumed that Ambassador Gibson means railway artillery and such tractor-drawn weapons as the 8-inch howitzer and the 240-mm. howitzer. Except for a very inferior railway artillery such weapons were unknown at the time of the Franco-Prussian War. France, still under the influence of the brilliant and victorious Napoleonic era, felt confident and secure but was due to suffer a rude awakening. So far as weapons were concerned, the armies of France and Germany in 1870 may be said to have been on an even footing. There was, however, a tremendous difference in their fighting value. The German army was well organized, well led, well trained, and knew it. The French army was a mere shell and did not know it. These are the real reasons why Germany so successfully attacked France and not any difference of weapons.

At the beginning of the World War tanks and poison gas were unknown but their complete absence from the armies of all the belligerants does not seem to have had any effect on the spirit of aggression of any of the combatants.

Why did Ambassador Gibson leave out all mention of aircraft? Surely the aircraft of today have a tremendous fighting power, both offensive and defensive.

BUT let us suppose that tanks, heavy mobile artillery and poison gas are abolished. What effect will it have? The relative strength of any armies that one may choose to compare will remain approximately the same even after these weapons have been removed from them, and it is hard to conceive how the feeling of security or the spirit of aggression is going to be effected in one way or the other.

Again, it may be said that the spirit of a nation largely determines its feelings of security and its aggressiveness, and these are practically independent of comparative armaments.

There is another condition necessarily present with every nation which has a strong influence upon all questions of security and that is the geographical position of the country. We in the United States fortunately have 3,000 miles of sea on one side and 6,000 miles on the other, while north and south of us we have friendly people. Our geographic position gives us a feeling of security that is difficult for us to evaluate properly. Likewise it may be said that the geographic positions of some of the nations of Continental Europe must of necessity arouse very different feelings among their people.

Weapons are important and the essential thing is that the soldier should feel that his weapons are quite as good as those of the enemy. The nation would not be doing its duty to its soldiers unless it made every effort to equip them with weapons in quantity and quality equal to those of any possible enemy. Indeed it should endeavor in every possible way to have its weapons superior to those of the enemy.

History also shows quite conclusively that superiority of defense over aggression has not been effected by doing away with any particular instrument by fiat or agreement. Weapons have been done away with to be sure but not because the pendulum swung from the aggressive to the defensive. Their passing was always due to improvement—the old making way for the new, just as today we have our obsolete and obsolescent pieces. The needle gun, the disappearing carriage, the Rodman, the Dahlgreen and the Parrott are gone not because they were too offensive nor too defensive but simply because they were not defensive enough. Newer developments have relegated types which were once the acme of the art to the haven of well remembered masterpieces of another day. How then could it be said that had the flint lock been stamped as the internationally permissible defensive arm the further development would have stopped there and no offensive piece would have taken its place. How can it now be said with other than academic finesse that the tank, for instance, is for use only in making the attack and not also in warding it off. Thus the hard fact that the principle of self-preservation always prompted improvement at one time for defense, at another for offense as the needs of the case demanded.

ONCE again, however, let us repeat an American maxim too well identified as the basis of our national defense philosophy to require undue emphasis: No believer in preparedness favors a race of armament. At the same time common sense demands adequate protection both for the nation collectively and for the individual soldier. Certainly a categorical grouping of weapons as offensive or defensive involves one of those academic distinctions which have little or no application in fact. In the final analysis security is a function of national policy, mental outlook, geographical location and military organization. The nation which casts aside these considerations and relies on the elimination of particular sizes or kinds of weapons because they are classed as defensive or offensive, as the case may be, hangs its security by a fine thread of technical distinction which does not exist in fact. The contrivances of old and their counterparts of today are implements of *security*—for attack at one moment, for defense at another, and for neither function exclusively. There is no weapon from catapult to coast defense gun, from arrow to aircraft, which is not both offensive and defensive as the needs and will of the user require. That, we believe, can be set down as the doxology of armament: it was in the beginning, is now and ever shall be.

Association Affairs

Alex Dow, Chief, Detroit Ordnance District

WE join its congratulations with the many friends of the Ordnance Department upon the acceptance of the leadership of the Detroit Ordnance District by Mr. Alex Dow. The automotive center of the world is beyond doubt one of the most important localities in the entire Ordnance industrial procurement organization. The Chief of the Detroit Ordnance District occupies a strategic place in our industrial preparedness program and the department is fortunate in obtaining the services of Mr. Dow, who is president of the Detroit Edison Company, for this undertaking. Born in Scotland, Mr. Dow received the degree of Master of Engineering from the University of Michigan in 1911 and honorary Doctor of Engineering from the same institution in 1924. He was an electrical engineer of the city of Detroit from 1893 to 1896, and water commissioner of that city from 1916 to 1921. He is a past president of the American Society of Mechanical Engineers and is identified with many engineering societies and organizations in this country and abroad.

ARMY ORDNANCE also extends felicitations to the new Detroit District Chief and offers every possible coöperation in furthering the progress of munitions preparedness in the area of which he has charge.

Colonel Spruance Receives Medal of Merit

COL. WILLIAM C. SPRUANCE, a vice-president of the Association and also of the Philadelphia Post, was presented the Ordnance Medal of Merit at a meeting of the Post on May 25, 1932. Although the award was made last October, this was the first opportunity to make the actual presentation due to the medalist's absence abroad. The medal and citation which accompanied it were presented on behalf of the officers and directors of the Association by Maj. Gen. Samuel Hof, Chief of Ordnance, U. S. Army. Mr. Philip H. Gadsen, President of the Post, presided.

It was the fifth annual meeting of the Philadelphia Post and was held at the Engineers' Club. The local section of the Society of American Military Engineers participated.

General Hof's presentation address follows:

"There are two reasons why I am especially pleased to participate in this significant meeting of the Philadelphia Post. The first is that I am afforded the opportunity to act in the name of the distinguished president of the Army Ordnance Association, General Crowell, who unfortunately is detained in Cleveland and who has asked me to act for him. The second and even more gratifying reason is that I have an opportunity as Chief of Ordnance of the Army to join in this tribute to Colonel Spruance whose outstanding record of service in the Ordnance Department during the World War and whose devotion to the ordnance cause since that time are of the highest rank.

"If I may be permitted to elaborate briefly upon the war service of Colonel Spruance I would like to recall for you that he was instrumental in solving one of the most difficult problems in the entire field of munitions in war time. Many of you remember that he came to the Explosives and Loading Division of the Department at a critical hour. We had never before been face to face with a problem which taxed the ingenuity of the engineer and administrator quite so definitely as that of meeting our huge ammunition requirements. While many other phases of ammunition production were difficult to solve, our gigantic needs for powder and high explosives and our unfamiliarity with loading technique on so vast a scale called for the unusual engineering talents and administrative ability which Colonel Spruance among the few was able to bring to them. The war record of the Ordnance Department in meeting a crisis in the history of explosives would not have been nearly as efficient and memorable without his contribution to it.

Col. William C. Spruance Receiving the Ordnance Medal of Merit from Maj. Gen. Samuel Hof, Chief of Ordnance.

"As Chief of Ordnance it is my pleasant duty to add my word of praise and congratulation to Colonel Spruance for all that he did and for the way he did it.

"As he was among the few who were qualified to undertake so vast a war-time program, so also was he one of the leaders of engineering and industry who sensed the vital importance of keeping alive among our citizens a knowledge of the progress and requirements of American munitions in time of peace. He was one of the prime movers in the establishment of the Army Ordnance Association fourteen years ago, and he has given to that important movement the same quality of leadership which he brought to his war-time assignment. He has been an official of the Association since its organization and has aided very materially in fostering among our younger engineering students at his alma mater, Princeton University, a method of interesting our young men in the importance of the ordnance problem.

"I know that all of you were as delighted as I to learn that the Committee on Awards selected Colonel Spruance among the first recipients of the Ordnance Medal of Merit when it was founded by the Association last year. No one more richly deserves this tribute from our organization. Unfortunately

Colonel Spruance was ill at the time of our annual meeting in October last year and could not be present to accept the award at that time. Since then he has been traveling around the world and it is only within the last month or so that he returned. The Association lost no opportunity in arranging for the actual bestowal of the Medal at this function of the Philadelphia Post of which Colonel Spruance is a Vice-President.

"In the name of General Crowell, President of our Association, it gives me special pleasure to confer the Medal upon Colonel Spruance. The Medal is known as the Ordnance Medal of Merit and this award carries with it the following citation: 'For unusual accomplishment and outstanding service in the advancement of industrial preparedness.' Colonel Spruance, on behalf of our colleagues of the Association I am delighted to present the Medal and the accompanying citation to you. I congratulate you upon this well merited honor."

The speakers at the formal meeting which followed the presentation ceremony were Col. Earl I. Brown, C. E., District Engineer, who spoke on "The Erosion of Sea Beaches," and Lieut. Col. Charles G. Mettler who presented an address on behalf of Brig. Gen. Samuel McRoberts, Chief of the New York Ordnance District, on "Procurement Districts and the Army Ordnance Association." In compliment to the medalist and the speakers an exceptionally large group was in attendance.

New York Post

THE second meeting of the year of the New York Post, held at the Brevoort Hotel April 22nd, was honored by the attendance of Maj. Gen. Dennis E. Nolan, Commanding General, Second Corps Area. Some two hundred guests enthusiastically received General Nolan's address in which he narrated experiences bearing on Army Intelligence. Other speakers were Brig. Gen. W. H. Tschappat, Chief of Manufacture, Ordnance Department, who delivered a short address of greeting to the members of the Post. Lieut. Col. A. G. Gillespie, Professor of Ordnance and Gunnery at the United States Military Academy, West Point, spoke on Japan and its people and the development of the present Japanese policy in the East, and Maj. Emile V. Cutrer, Inspector General, First Division, Governors Island, spoke on his experiences in China as Military Attaché, and explained the Chinese attitude toward questions in the Far East which are now claiming world attention.

The meeting was conducted under the chairmanship of Col. James L. Walsh, President of the Post, who discussed present conditions and emphasized the necessity for preparedness from both the standpoint of the Army and of the citizen with special reference to the citizen's duty in connection with the present crisis in our industrial affairs. Lieut. Col. Charles G. Mettler, Executive Officer, New York Ordnance District, was toastmaster. The following distinguished guests were presented at the meeting: Brig. Gen. Samuel McRoberts, Chief, New York Ordnance District; Brig. Gen. John Ross Delafield, Commander-in-Chief, Military Order of the World War and Counsel of the Army Ordnance Association; Mr. William C. Dickerman, member of the Advisory Board, New York Ordnance District, and President of the American Locomotive Company; Mr. H. Hobart Portar, also a member of the Advisory Board and President of the American Water Works and Electric Company, and Col. Douglas I. McKay, an Advisory Board member and President of the Standard Coupler Company.

Other guests included Col. Kenyon Joyce, Assistant Chief of Staff, G-2, Second Corps Area; Colonels James E. McNary and Henry B. Machen, Vice-Presidents of the New York Post; and Maj. Thomas A. Morgan, President, North American Aviation and a member of the Post's Executive Committee.

Following the addresses, the Nominating Committee of the Post reported the unanimous election of the following Post officials for the years 1932-1934: President, General McRoberts; 1st Vice-President, Colonel Machen; 2nd Vice-President, Col. F. W. Roller; 3rd Vice-President, Colonel McNary; 4th Vice-President, Capt. Robert Boettger; Secretary, Lieut. Col. Charles G. Mettler; and Treasurer, Lieut. C. Wingate Reed. Colonel Walsh then turned over the presidency of the Post to General McRoberts who outlined his policy with reference to the conduct of the organization and who appointed the necessary committees including one to consider future meetings of the Post.

St. Louis Post

MAJ. L. H. CAMPBELL, JR., of Rock Island Arsenal, an authority on automotive equipment of the Army, was the principal speaker at a meeting of the St. Louis Post held at the Engineers' Club, St. Louis, April 22nd. The gathering was a joint assembly of the Post and the local section of the American Society of Mechanical Engineers.

The speaker reviewed ordnance automotive equipment from the World War to the present time in an able and interesting address. Moving pictures of mechanized equipment and tests of the Christie tank at the Aberdeen Proving Ground were used.

The meeting was presided over by Mr. L. C. Farquhar, chairman of the A. S. M. E. section, who in turn introduced Col. Harry Scullin, President of the Post. The meeting was preceded by a dinner at which there was an exceptionally large attendance. The officers of the Post were in charge of arrangements for the meeting. They include, in addition to Colonel Scullin, Col. E. D. Campbell, Maj. W. C. Bliss and Capt. L. J. Dillon. Maj. E. H. Sager, Ord. Res., was in charge of general arrangements.

Washington Post

GEN. PEYTON C. MARCH, U. S. Army, Ret., World War Chief of Staff, was the guest of honor and principal speaker at the spring luncheon-meeting of the Washington Post which was held in the Italian Garden of the Mayflower Hotel May 17th. Regular and Reserve Officers of the Field Artillery participated in the meeting which was well attended. Lt. Col. Earl McFarland, President of the Post, presided.

General March gave an interesting address in which he elaborated on his World War experiences applying some of them to present day national defense problems. He characterized recent efforts to consolidate the Army and Navy into a department of national defense as a thoroughly unsound doctrine declaring that success in war requires always subdivision and not concentration. He praised in highest terms the progress of ordnance development since the World War and spoke enthusiastically of the utilization of commercial articles, notably automotive vehicles, wherever possible. He referred particularly to the motorization of field artillery equipment using standard commercial vehicles and urged that special equipment be not utilized whenever there is a satisfactory peace-time substitute.

Maj. Gen. C. C. Williams, Chief of Ordnance 1918-1930, introduced General March and elaborated on the aims and purposes of the Army Ordnance Association as well as upon the outstanding record of the former Chief of Staff. Referring to the distinguished war leader General Williams said:

"Mr. Frederick Palmer has recently published a book entitled 'Newton D. Baker—America at War.' It contains of course many references to General March and his work and I shall make one or two brief quotations which seem to me to be well stated. First Mr. Palmer says, 'A college graduate before he went to West Point, thoroughly grounded in military history and principles, March seems to have learned from his training and his experience that the business of a soldier is to be a soldier to the limit when war comes, and that the supreme quality in a soldier should be decision. War was action, and procrastination an unforgivable failing.' Mr. Baker himself wrote about General March, 'I find his judgment quick and sure, and he seems to have the ability to inform his judgment by a study of details, which is rather rare in so quick a mind'."

"Also I hope you will permit me to make one more quotation,

this time from General Max Hoffmann, a most distinguished officer in the German Army. At the time of the Russo-Japanese War, General March and General Hoffmann were with the Japanese Army serving as military observers and came to know each other very well. General Hoffmann says, 'I was specially intimate with Captain March, who gave me English lessons, and who was exceedingly sympathetic to me owing to his intelligent military views and his straightforward and outspoken opinions.'

"My own experience with General March was spread over a considerable number of years. First I served with him at the Artillery School at Fort Monroe and then under him as a lieutenant in the Astor Battery in the Philippines. My most important experience with General March, however, was during the World War. He ordered me back from France to be the Chief of Ordnance and I shall never forget when I reported to him for duty after my return from overseas. My instructions were very brief and I think might be very well sumed up in one sentence, that every effort must be made to meet the calls of the A. E. F.

"From time to time it was, of course, my duty to take up questions with the Chief of Staff. General March always listened to what one had to say concerning the question under discussion and then promptly gave his decision, yes or no. Once that decision was given, everybody recognized that it was final. There is, perhaps, nothing that forwards the work of a bureau chief more than prompt decision, yes or no, concerning the various questions that arise.

"General March's responsibilities were not only concerned with the military side of the War Department, but many industrial questions came directly up to him. The quick and sure judgment of which the Secretary of War spoke seemed always to be in play and not only did General March have the complete confidence of his military assistants but he likewise had the confidence and respect of the industrial leaders who were called to Washington during the war."

Included among the special guests were the Assistant Secretary of War, Hon. Frederick H. Payne; Assistant Secretary of War for Aeronautics, Hon. F. Trubee Davison; Maj. Gen. Samuel Hof, Chief of Ordnance; Maj. Gen. Samuel D. Sturgis, F. A. Ret.; Brigadier Generals William H. Tschappat and Edwin D. Bricker, Assistants to the Chief of Ordnance; Hon. Swagar Sherley, Chairman of the Appropriations Committee, House of Representatives, during the World War; Mr. A. Felix duPont, Wilmington, Del.; and Col. C. M. Wesson, Chief of the Technical Staff, Ordnance Department.

Necrology

ARMY ORDNANCE announces with regret the death of John Walter Lees, Vice-President of the Inland Steel Company, who was familiarly known among his associates of the steel industry as the "father of Indiana Harbor." A native of that city, Mr. Lees began his industrial career as a machinist and became Vice President of one of the largest independent steel mills with the normal employment of more than 7,000 men. He was well known for his philanthropic activities and was always interested in the industrial preparedness movement sponsored by the Army Ordnance Association.

During the World War he was a leader not only in industry but in the various activities of his community. He participated in Liberty Loan drives and Red Cross work while pushing to the utmost the production of his company's plants in the manufacture of munitions and other Army supplies.

Col. William A. Starrett

THE last issue of this Journal had gone to press when word was received of the untimely death on March 26th of Col. William A. Starrett, a member of the Army Ordnance Association for many years and one of the foremost construction engineers of his day. While the work of Colonel Starrett brought much commendation for his peace-time construction activities, the leading monument of which is the Empire State building in New York, his friends and associates of war days are not unmindful of his achievements for the Army in the days when the General Munitions Board, progenitor of the Council of National Defense, was first organized. Colonel Starrett brought to the difficult task of completing the $150,000,000 construction program of the Quartermaster Department the experience and ability which were essential for its success. He organized the Council's famous Committee on Emergency Construction, and with time as the essence of its activities he successfully completed the program of housing our troops at the training centers.

While not essentially connected with the huge ordnance program of the war, Colonel Starrett was a leading influence in preparedness activities and contributed no less distinguished service to the general cause than he did as architect and builder at a time when housing our growing Army was a problem to tax the ingenuity of our greatest minds. His record of service will not soon be forgotten in the annals of our World War effort.

SINCE publication of the last issue of ARMY ORDNANCE notice has been received of the death of the following members of the Association: R. L. Baird, Hamden, Conn.; and E. H. Inman, Atlanta, Ga. To the relatives and friends of these deceased members the Association extends condolences.

New Members

THE following have been admitted to membership in the Army Ordnance Association since the last issue of ARMY ORDNANCE: W. Clark Adams, Chicago, Ill.; C. T. Almquist, Norman, Okla.; John H. R. Arms, New York, N. Y.; W. Attwood, New York, N. Y.; Edgerly W. Austin, Detroit, Mich.; Hal B. Coats, Ann Arbor, Mich.; Richard B. Cooney, Pittsburgh, Pa.; Edward F. Dirks, Bayonne, N. J.; Myron E. Doucette, Brooklyn, N. Y.; Norman C. Einwechter, Philadelphia, Pa.; Richard T. Fleming, New York, N. Y.; R. E. Helfinstine, Dayton, Ohio; Wilbur F. Howell, New York, N. Y.; Emil J. Ketonen, White Plains, N. Y.; William F. Krug, Jr., Wilmington, Del.; Robert B. Lea, Brooklyn, N. Y.; Carl A. Loeb, New York, N. Y.; Joseph E. Michaels, Chicago, Ill.; Arthur A. Nichols, Waltham, Mass.; W. Hart Nichols, Waltham, Mass.; T. A. O'Barr, Gibbstown, N. J.; Olof Ohlson, West Newton, Mass.; John E. Owen, Belle Vernon, Pa.; Halford W. Park, Greenwich, Conn.; Lloyd G. Penney, Baltimore, Md.; Myrle M. Perkins, Cambridge, Mass.; J. Louis Reiber, University City, Mo.; R. A. Rose, Harlingen, Texas; Charles A. Rowan, Wilmerding, Pa.; Philip A. Salmon, New Hope, Pa.; Wm. M. Spinrad, Brooklyn, N. Y.; T. F. Utley, Cleveland Heights, Ohio; Bernard Victor, Bogota, N. J.; Charles H. Ward, Philadelphia, Pa.; Harold P. Whitenight, Collegeville, Pa.; and K. H. Woolson, Springfield, Vt.

Membership Committee

UNDER the chairmanship of Lieut. Col. LeRoy Hodges, of Richmond, Va., the Committee on Membership is accomplishing splendid results in obtaining new members of the Association. Other members of the Committee are J. E. McNary, New York, N. Y.; W. M. Moody, Berkeley, Calif.; George P. Slade, Providence, R. I.; Chas. Z. Tryon, Philadelphia, Pa.; E. D. Nims, St. Louis, Mo.; and James G. Cowling, Milwaukee, Wis. By authority of the Board of Trustees the Committee is authorized to award the lapel emblem in 14 kt. gold to members who bring in five new members. The recipient of the award during the month of May was Mr. Theodore E. Moritz of Chicago. All members are urged to assist the Committee in maintaining the membership level of the organization especially during the current economic situation.

Communications

Ordnance Supplies for the Theater of Operations

THE EDITOR:

The article entitled "Ordnance Service," by Maj. H. S. Aurand, Ord. Dept., in the March-April issue of ARMY ORDNANCE is such an excellent one that I hesitate to find any fault with it. However, the first paragraph in the right-hand column on page 317 requires further study before it can be accepted as standard doctrine in Ordnance Service.

In the first place, shipping forward the "estimated average expenditure per day of the various items of supply, except ammunition" is bound to be very wasteful, or else large quantities of certain items will have to be returned to some depot to be reassembled again into fixed sets of supplies. In the second place, if ammunition is to be excepted and sent forward only on requisition as required why cannot this same system be applied to general supplies?

I doubt that more than a few people know that appended to Standard Nomenclature Lists for major items of Ordnance matériel (machine guns, carts, rifles, pistols, field guns, caissons, etc.) are lists of basic spare parts and equipment. These lists show estimated quantities required for the maintenance of a certain number of the corresponding major items during seven days intensive warfare, or one month under normal conditions in the theater of operations, or six months during peace.

These sets of basic spare parts and equipment are the initial equipment of Ordnance maintenance companies for their maintenance activities and in addition they are the source from which the using arms replace spare parts and equipment lost or used up by them.

These lists are not long and are prepared for most of the major items. In case of an emergency they can be printed in the form of a prepared requisition showing the names, piecemarks and quantities of the items in the standard set and blank columns for entering quantities required. Blank lines can also be provided for new or additional items.

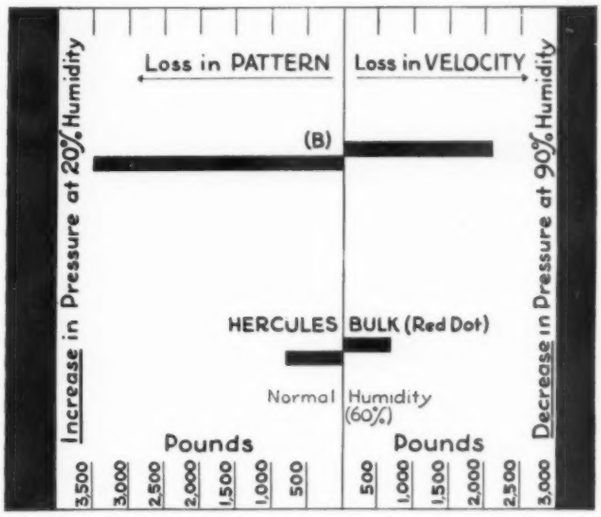
Within a typical field army there are nine division, three corps artillery brigade, three heavy and one small arms maintenance companies, or a total of sixteen sources from which requisitions will be received. If the army depot has its supplies arranged in storehouse fashion it will be able to fill these requisitions from its bulk stocks. One requisition can go from this army depot to the source of supply in the rear for replenishment of its stock. It is assumed of course that the bulk stocks will be carried and stored by the army depot in what might be called bin-chests. One such bin-chest should be so constructed that it can contain, in separate compartments, many different parts for the U. S. Rifle, Cal. .30, for instance. Another bin-chest would contain nothing but the rifle bolts, etc.

The procedure outlined above will allow great flexibility in use of supplies, will reduce the tonnage of shipments forward, and will reduce wastage.

FRANCIS A. ENGLEHART,
Washington, D. C. *Major, Ord. Dept., U. S. Army.*

THE EDITOR:

The article "Ordnance Service," in the March-April issue of ARMY ORDNANCE, discusses in an admirable and illuminating manner one of the most important and, paradoxically, one of the most neglected subjects within the scope of Ordnance ac-



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This chart is one of a series which will appear in this publication. They emphasize that every trapshooter who wants to get the most out of his own skill, day in and day out, rain or shine, should be sure he is shooting Hercules Bulk (Red Dot).

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tivities. It is a foregone conclusion that certain of the statements and views of the author will be accepted with reservations, while others, according to the viewpoint of the reader, may be contrary to his ideas and beliefs.

In several instances the statements made are contradictory. For instance, "There will be no need to sell Ordnance supplies in war time" and, regarding the Technical Staff, "Rather they should busy themselves with discovering how the Ordnance supplies already on hand in the theater of operations, or in production at home, can be successfully employed under the special conditions which will be found in any theater," are contradictory in the extreme. The outlined function for the Technical Staff is the highest type of sales promotional work, requiring the utmost tact in addition to an intimate and detailed knowledge of the characteristics and functions of the supplies available as compared with those requested. No officer of the Ordnance Department should consider his professional education as complete until he has mastered the art of salesmanship and can convince the buyer that available supplies will meet his needs. Otherwise the handling of Ordnance supplies degenerates into mere order taking, with a loss of morale on the part of the seller and a lack of confidence on the part of the buyer.

Millions of dollars were needlessly spent during the World War because Ordnance officers lacked in salesmanship. In one instance an officer made a hurried trip to Switzerland to obtain six submarine type watches for issue to an artillery brigade whose Commanding General had an obsession for time synchronization. Good salesmanship would have placated the Commanding General and avoided an unnecessary trip and expense. This subject might be exhaustively covered, and it is hoped it will be, by some competent authority.

As past experience appears to be the only logical guide in predicting the future, the organization set-up appears faulty. Too many functions are assigned to the office of the Chief Ordnance Officer, and too few to the Ordnance office of the lines of communication. Whether the Chief Ordnance Officer is located at General Headquarters or Headquarters, Line of Communications, does not affect his relations to the Commander in Chief, as the Headquarters, Line of Communications is merely the rear echelon of General Headquarters while its commander is in reality a Chief of Staff for special Staff. Especially in large operations, too close physical proximity to the Commander in Chief is undesirable. An office of this nature will function to far better advantage when remote from operating staffs.

The conception regarding balanced stocks is not agreed with. It is admitted that "days of supply" will be set up for the several echelons, the number of "days of supply" being based upon the area of storage facilities, replenishment time element, and the predicted stability of the combat area. Balanced stocks are bulk stocks available in such quantities as are required to meet anticipated demands for predetermined days of supply. In general, the nature of ordnance supplies prevents the use of days of supply and bulk stock beyond the army depot, but an army depot which is so lacking in facilities and personnel that it is merely a forwarding point has no good reason for existing and constitutes the proverbial fifth wheel. For example, a small arms center (part of army ordnance) must have supplies in large quantities not only for issue but for use. The repacking of these bulk supplies into sets of supplies and constantly forwarding the sets when probably only one or two items from the set are needed is the most wasteful practice conceivable. It sets up conditions paralleling those where we fixed a "load" for every vehicle. In following this same principle during the war, certain organizations with two blacksmiths, two saddlers and two carpenters received 13 blacksmith's outfits, 13 saddler's outfits, and 19 carpenter's outfits. It took years of effort to kill the "load" idea, which the author has reincarnated under another name.

One of the surprising statements is that "ammunition . . . in intermediate and advance depots (is stored) by complete

rounds." While it is true that the Ordnance Department is improving its methods of manufacture and assembly to the point where it will soon be practicable to store and ship fuzed high explosive shell of the smaller calibers (3-inch and under), this is improbable with heavier and separate loading projectiles. It would seem the height of folly to store primers and fuzes with projectiles and/or powder charges, or bomb fuzes with bombs.

In spite of the above criticisms, the author is to be congratulated for the excellence of the article as a whole, as it indicates thorough research and a broad grasp of fundamental principles.

E. H. MYERS,
Ordnance Department.

Washington, D. C.

The Ordnance Depot at Mehun-sur-Yevre

THE EDITOR:

I have just read your interesting issue for March-April and note with unusual interest Colonel Brady's article on "Unknown Soldiers."

Being one of the unfortunates who had to spend considerable time at Mehun-sur-Yevre, I appreciate Colonel Brady's tribute to the many Ordnance men who labored at the mud-hole madhouse, as it is correctly described by the author. The illustrations made from photographs, most of them taken after I left Mehun, revive a great many recollections.

You may be interested in my telling you as a former Mehunite that Colonel Brady has done an excellent job in writing a tribute to those who had in many ways a disheartening assignment in the A. E. F.

On page 311, the author speaks of the forge shop that was set up in the mud, and the hundreds of wrenches and tools that were there made for the artillery. As a matter of fact the "hundreds" were in small denominations, about 300 wrenches representing the entire product of that forge shop. Colonel Brady speaks also of a "smelting furnace" ready by the time of the Armistice "to melt down the millions of shell and cartridge cases into ingot metal that was badly needed by the Allies." This sounds good—better than it was. The melting equipment consisted of two cupolas, only one of which was finished. It was never operated. The brass furnace was never finished. Incidentally, a cupola is not a suitable medium for producing the ingot metal contemplated.

How do I know this? I was in charge of the forge shop and foundry, and was automatically made the custodian of some 60 carloads of metal salvage consisting of German shell cases, rifles, flame throwers, grenades, and what-not, picked up on the battlefields and shipped back to Mehun to use for the recovery of the metal.

I am sending a copy of this letter to Colonel Brady. I wish you and he to understand that I don't feel cross about his exaggeration concerning the actual service performed by the shop of which I was in charge until I left Mehun in January, 1919. On the whole, Colonel Brady has done a very good job and has rendered a service to others like himself who were so unfortunate as to be assigned to the most God-forsaken place I ever saw. That statement stands in the face of my rather extensive travels, including a sojourn to the Klondike in 1898.

R. A. BULL,
Formerly Major, Ord. Dept., A. E. F.

Chicago, Ill.

Editor's Note: In the interest of constructive discussion of all topics in its field of activities, ARMY ORDNANCE invites its readers to contribute to its Communications column. Expression of opinion is as helpful to the progress of American munitions as it is to all other endeavor. Letters, ordinarily, should not exceed three hundred words in length. Anonymous contributions will not be considered for publication.

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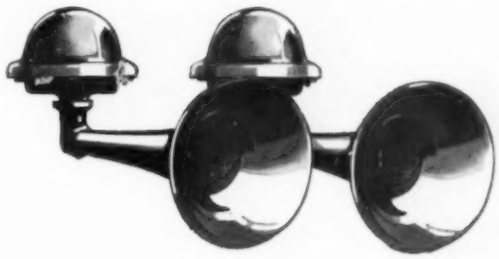

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Professional Notes

Machine Guns in Rifle Squads

TO determine the advisability of adding light machine guns to the present equipment of rifle companies in infantry regiments of the Army will be the object of a series of tests to be made by the 34th Infantry at Ft. George G. Meade, Md., this year.

For the proposed tests six Browning light tank machine guns will be issued and will be carried on all field maneuvers and tactical exercises during the ensuing months. A report is called for by November 15. The guns are of the standard caliber .30 as used in tanks, with certain modifications to permit greater ease in carrying, added protection for the sights, and shoes on the tripod legs to insure stability in firing.

It is prescribed that one gun and equipment be issued to each section of either two or three squads, the machine gun squad to consist of one corporal, a gunner, assistant gunner and five ammunition carriers. All will carry rifles except the two gunners who will be armed with pistols in addition to carrying the machine guns.

The ammunition will be carried in expendable containers, containing eighty rounds each, provided with slings for ease in carrying by the various squad members, a total of 1,120 rounds to be issued to the squad. On the basis of a war-strength organization the addition of these guns to all sections would materially increase the present fire power of an infantry regiment.

As now authorized, there are three machine gun companies (one in each battalion) of 12 guns each in the regiment, all of the heavy, water-cooled type. With the nine rifle companies equipped with the light machine guns, a total of 54 additional guns of this type would be added. These light tank guns are air-cooled, but fire the same ammunition as the rifle and heavy machine gun.

Some of the questions for which the tests are designed to furnish at least a partial solution are: whether or not light machine guns should be included in the armament of infantry rifle companies; whether the present automatic rifle now issued on the basis of one per squad should be displaced entirely; and whether or not a squad equipped with this type of machine gun and its equipment can keep up with the other rifle units under conditions approximating those encountered in combat.

Bullet Velocities and Armor Plate

THE claims of Dr. Gerlich regarding the attainment of exceptionally high velocities for rifle bullets continue to interest observers throughout the world. ARMY ORDNANCE has published in recent issues statements of the inventor as to the results of his developments. The subject is one which has called for much comment. If such velocities are actually obtainable in service arms, the entire tactics of battle will be radically affected. However, even the Gerlich claims prompt the following comment from our contemporary, *The Army, Navy and Air Force Gazette* (London), as to the counter developments of armor in proof of the age-old fact that new offense is always met by similar defense. The *Gazette* records:

"It is claimed that a bullet of remarkable armor-piercing powers has been discovered by a German, Gerlich, once an employee of Vickers-Armstrongs. The muzzle velocity achieved by the 'Halger-Ultra' bullet, as it is called, is variously described as 5,000 and 6,000 feet per second, which is more than double that of our service bullet (2,440 feet per second). This

velocity is achieved by having a driving band of increased size, shaped rather like a lady's skirt, and by firing the bullet out of a rifle which tapers towards the muzzle and is thus conical, whereas the usual rifle barrel is cylindrical. The effect is to give a wider area against which the gases generated by the propellant may act, and to prevent their escape over the driving band. No great difference in the amount or quality of the propellant is necessary in view of these improvements in design.

"Using a rifle of .280-in. caliber, Herr Gerlich has successfully pierced armor .46-inch. thick, and with a .303-in. rifle .58-in. thick. Thus apparently it may be possible to have an antitank weapon able to be carried by a single man, and if this is so, the value of the tank as an assault weapon would be definitely lessened.

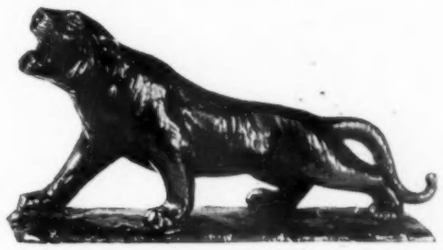
"There are, however, two factors which affect the situation radically. It has not yet been proved, so far as is known, that the bullet is effective at a range of over a few yards unless the caliber is greatly increased, and it is announced that the new light tanks now being delivered are armed with a new armor plate providing an increase of resistance of over 40 per cent, which will thus be impenetrable by this bullet at any range, provided its caliber is not more than .303-in.

"For the time being the tank remains invulnerable, but it can only be for a time if Herr Gerlich's claims are substantially true, as they may well be. Science has always provided the antidote to every new weapon of war, and the tank will be no exception.

"Almost simultaneously with the announcement of Herr Gerlich's new bullet comes the news of a new armor-piercing projectile. Sir Robert Hadfield announced recently that his company had been able to produce a new shell which would perforate hard-faced armor of one foot in thickness, inclined 30 degrees, at a velocity equivalent to a range of about 15,000 yards. If this claim is correct it may have a profound effect on naval construction. To what extent the new projectile is an advance on that evolved after the Jutland action it is important to discover. It will be recalled that Lord Jellicoe, in his book on 'The Grand Fleet,' said that the Jutland battle convinced us that our armor-piercing shell was inferior in its penetrative power to that used by the Germans. At his instigation, the matter was thoroughly investigated, and in 1917 a shell of a new type was produced. Whereas the old type would, with oblique impact at battle range, break up while holding a certain thickness of plate, the new shell would at the same oblique impact and range pass whole through a plate of double the thickness before exploding. It could, with a delay action fuze, penetrate to the magazines of the German ships. 'Had our ships,' said Lord Jellicoe, 'possessed the new type of armor-piercing shell at Jutland, many of the enemy's vessels, instead of being only damaged, would probably not have been able to reach port.'"

The Royal Army Ordnance Corps Gazette in its issue of April, 1932, commenting on the same subject, points out similar interesting progress:

"For all the disarmament talk at Geneva, armament design and construction proceed apace and there is no slackening in the age-long duel between armor and the projectile. It is reassuring to learn that the extensive reduction in armament which Britain, alone among the Great Powers, has carried out, is being offset by the power and efficiency of her latest weapons of war. Here are two instances. Half an ounce of lead, in the form of the bullet, has long dominated the battlefield and it established the four years' deadlock on the Western Front. The antidote came with the half-inch of steel, the mobile armor which carried the soldier across the trench and this half-inch of steel is revolutionizing tactics. But recently the supremacy of the tank has been threatened by the Halger-Ultra rifle and bullet, the invention of a German engineer, Herr Gerlich. Exhaustive tests in Germany showed that this supervelocity bullet easily pierced 12-mm. (half an inch) of the hardest and newest



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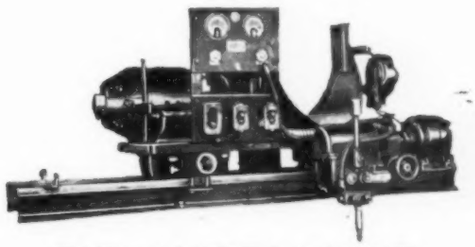

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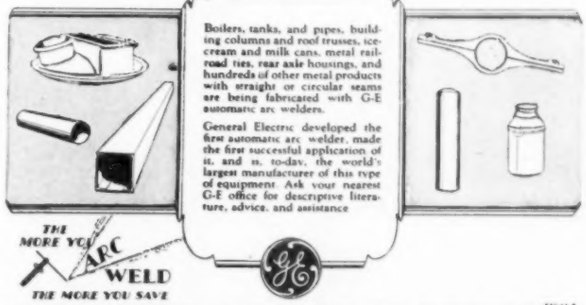
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types of armor plating, while owing to its tremendous smashing and blasting power, the torn out fragments would act with terribly destructive effect on the tank crew. The British answer was given even before the challenge was made. British armament research has produced armor plating with 40 per cent greater resistance for the same thickness than heretofore, so that half an inch of this plate is proof against the new bullet, even at point-blank range. Our new light tanks now being delivered are equipped with this plating, the thickness of which is sufficient to resist the Gerlich bullet with a good margin of safety. True the invention is adaptable to larger weapons, but its real danger has gone. This lay in the possibility of giving the ordinary infantryman a weapon capable of piercing tank armor.

"Comparable in a larger ballistic sphere to the Halger bullet is the latest type of shell being produced for our Navy. It is made in two varieties, A. P. and H. E., and in calibers of 6-in., 8-in., 15-in., and 16-in. Its secrets lie in the composition of the steel which combines hardness and toughness in a phenomenal degree, and in its conformation which reduces air resistance to the minimum and so ensures exceptional accuracy. The new shells can go through any armor plate, however hard and tough, at normal fighting ranges, while the explosive type is detonated well inside the ship with tremendous violence, owing to the very H. E. charge that the large internal capacity of the shell allows. The introduction of these shell has greatly increased the destructive power of our naval ordnance and restored the position of the gun among the weapons of sea warfare."

Armored Car Progress

THE first unit of ten armored cars, T4, made its appearance in Washington recently en route from the Rock Island Arsenal to the Aberdeen Proving Ground. Notwithstanding newspaper statements, based entirely upon imagination, that the vehicle was rushed to Washington for emergency use in the event of threatened demonstrations by bonus and Communist agitators, the new unit elicited much praise from observers who inspected it during its brief visit to the capital.

The vehicle is completely armored and is the first of ten units to be completed.

In addition the two original pilot cars, the bodies of which were fabricated of soft steel plates, are to be returned to the arsenal and armor plate substituted for the soft steel plates. Drawings have been forwarded to the arsenal covering a flexible detachable track, with instructions to manufacture one set for test on one of the new cars. This track consists of a flexible fabric and rubber belt, to which at stated intervals a track shoe of alloy metal is fastened; this track is adapted for use on the rear bogie unit and should materially increase the flotation of the vehicle for cross-country mobility and operation off roads.

All of the ten cars under manufacture will be equipped with a combination .30 and .50 caliber machine gun mount; in addition five of the vehicles will be radio equipped. Action has been taken looking to the standardization of this vehicle as Armored Car M1.

Fire-Control Apparatus for Field Artillery

A 50-cm. base range finder recently purchased by the War Department is on exhibition at Fort Meade, Maryland, where all interested parties will be afforded an opportunity to use or test the device in actual work. The instrument is light, small in bulk, easily used and easily kept in adjustment and has possibilities for Infantry and Tank application. There are no moving parts for ranging purposes, the stereo range scale being fixed in the field of view.

Other developments of fire-control equipment include preliminary tests of a newly produced field glass of the Bausch and Lomb Optical Company. It is an eight power instrument, with large objectives 56 mm. in diameter. It is light in weight compared with similar types of glasses of foreign manufacture.

Book Reviews

Faraday and his Metallurgical Researches. By Sir Robert A. Hadfield, Bt. London: Chapman and Hall, Ltd. 1931. 21 s.

SIR ROBERT HADFIELD, who ranks among the leading metallurgists of his day, has performed a magnificent service in presenting this unusual book. The distinguished author who holds the Bessemer Medal of the Iron and Steel Institute and whose researches and developments in the field of armor plate entitle him to unique distinction, pays this tribute of devotion to the great Faraday in interesting detail and elaborate discussion. He has made a thorough investigation of all literature and documents bearing on his subject, and has unearthed many valuable facts which are included in his text.

Sir Robert's book is not a complete biography of Faraday nor is it intended to be such. It is rather a review of ferrous metallurgy leading up to the "first and most laborious" of Faraday's major researches, that on steel and alloys.

Most interesting is the detailed account of Sir Robert's own researches on the specimens of steel alloys preserved in the now famous Faraday's box at the Royal Institute. This is an elaboration of the paper with which many of our readers may be familiar and which the author entitled "A Research on Faraday's 'Steel and Alloys'" which appeared in 1931. Moreover Sir Robert includes in the book further researches on another group of Faraday's specimens which are preserved in the Science Museum. There is a comprehensive appreciation of Faraday's metallurgical researches together with an account of the progress in the development of alloys and steels down to our own day.

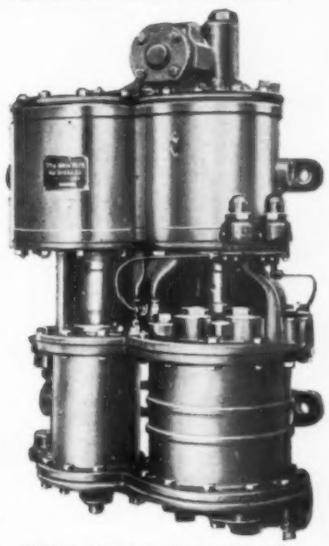
Sir Robert has included in his text a wealth of material on alloy steels not only as to developments in his native country but in the United States as well. The discussion of steels for armament purposes, which is necessarily limited, is itself a tribute to the author because the Hadfield armor-piercing projectile is not the least of his chief claims of fame. This is one of those monumental works for which readers of the present and the future must hold Sir Robert in renewed esteem.

Over and Above the Call of Duty. E. I. duPont de Nemours & Co., Inc., Military Sales Division. Wilmington, Del. 1932.

THIS is a booklet of some 44 pages containing a series of advertisement published in ARMY ORDNANCE and other journals by the duPont Company during the early 1920's depicting some of the inspiring achievements of officers and men and military organizations in historic engagements of the United States Army. As the preface to the booklet notes, the military history of our country contains many instances of distinguished service above and beyond the call of duty. The material for these stories was contributed by the officers and men of the military services and they are published in this form by the company in tribute to those who played the leading roles in their enactment.

Readers of this Journal are no doubt familiar with this series of advertisements, which for artistic presentation and historical fact, are unexcelled. Thus far the booklet has had limited distribution but it is intended later to supply it to the general public at ten cents a copy. There are much inspiration and valorous fact to be gained from a perusal of this little volume.

For Industrial Use
We are Prepared to Furnish



8½"-120,
8½"-150,
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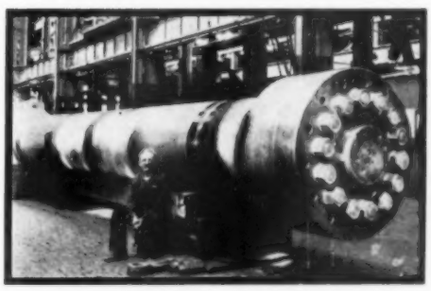
Cross Compound
Compressors.
Also the New
High Pressure 7⅝" Cross Compound
Compressor for Superheat Steam

The New York Air Brake Co.
420 Lexington Ave. NEW YORK



This pressure vessel, forged from an ingot of Chrome-Vanadium Steel, is over 52 feet long, with 24-inch bore, 9-inch wall thickness and flange diameter of 54 inches.

6 Years' Service
At Pressure of 4,400 Lbs.
Temperatures from 400° to 575° F.
In Atmosphere of Corrosive Gases

FOR almost six years, the forged Chrome-Vanadium Steel pressure vessel illustrated above has been in continuous service, at pressure of 4,400 pounds per square inch, with temperatures varying from 400° F. to 575° F., in an atmosphere of corrosive gases.

Recently, the inner surface of this vessel was subjected to a thorough metallographic examination, and found to be unaltered in every respect! Similarly satisfactory performance is being rendered by many other Chrome-Vanadium Steel pressure vessels serving under severe conditions in many countries, including Europe and the Orient.

Chrome-Vanadium Steels possess excellent mechanical properties at both room and moderately elevated temperatures. They are exceptionally uniform, especially in large masses, and are adaptable to all fabricating operations. Because of these advantages, Chrome-Vanadium Steels have been widely employed for production of large ingots for conversion into forged pressure vessels and also for production of both light and heavy plate for the construction of welded units.

If you design, build or use pressure vessels for any service, our Metallurgists will gladly send you complete information on the analyses, properties and advantages of Chrome-Vanadium Steels that have given outstanding performance in pressure vessel service. Write us today.

VANADIUM CORPORATION OF AMERICA
120 BROADWAY, NEW YORK, N. Y.
CHICAGO PITTSBURGH DETROIT
Straus Bldg. Oliver Bldg. Book Tower
Plants at Bridgeville, Pa., and Niagara Falls, N. Y.
Research and Development Laboratories at Bridgeville, Pa.

VANADIUM-ALLOYS
FERRO-ALLOYS of vanadium, silicon, chromium and titanium; silico-manganese, tungsten and molybdenum, produced by the Vanadium Corporation of America, are used by steel makers in the production of high-quality steels.

Chrome-Vanadium Steels
For Forged and Welded Pressure Vessels

TIMKEN
Tapered
ROLLER BEARINGS

for full anti-friction efficiency and radial-thrust load protection in motor trucks, tractors, tanks, gun carriages and all types of ordnance equipment and industrial machinery.

Timken Bearings carry all loads simultaneously—radical, thrust or both together in any combination.

For over 30 years the standard of the automotive industry.

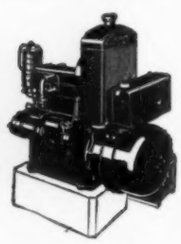
The Timken Roller Bearing Co.
Canton, O.

Tapered Roller
TIMKEN BEARING
EQUIPPED

A Sure Guide to Mechanical Excellence and Dependability

UNCLE SAM KEEPS HIS WEATHER EYE OPEN!

This government tug, used by the Corps of Engineers in Inspection Service, has a Model D Kohler Electric Plant which furnishes current for general lighting. Many other vessels belonging to the War Department are equipped with Kohler Plants. Available from 800 watts to 25 KVA capacity, generating standard electric current at 110 or 220 volts A. C. or D. C.



KOHLER
OF
KOHLER

The Manufacturers of Plumbing Fixtures

Zeppelins Over England. By Trensch von Buttlar Brandenfels. New York: Harcourt, Brace and Company. $2.50.

BRANDENFELS was an officer in the German Naval Airship Service and in command of various Zeppelins during the World War. The title, however, is somewhat misleading, since only some ninety-odd of the three hundred and twenty pages are devoted to raids over England. Its title should probably have been "Trials, Tribulations and Pleasures of an Airship Officer." The dangers and escapes from death are described in such realistic fashion that one almost lives through them while reading, and the pleasures also are fully depicted. The author states that at the beginning of the World War Germany was anything but prepared in her airship service, but construction went on apace, each ship being an improvement over its predecessor. On the day of the Armistice seventy-eight Zeppelins had been built, of which fifty-two were lost. The book is devoted entirely to the author's personal experiences and furnishes sufficient excitement for an evening's reading, since it is a tale containing both humor and tragedy, written in the modest style of a true seaman.

Hindenburg. By Gerhard Schultze-Pfaelzer. New York: G. P. Putnam's Sons. 1932. $5.00.

THIS book, covering Peace, War and Aftermath, is a scholarly exposition of Hindenburg's life, character and aims, all erected on the solid foundation of duty to the Fatherland. When the ruthless militarism of the German commander was suddenly translated into the realm of statesmanship, the whole world stood aghast with the thought that Europe would never be stabilized during this man's lifetime. But when one reads of the inflexible integrity of the man, of how the oath of allegiance to the new republic caused the breaking down of personal views in the interests of the Fatherland, one quickly revises all preconceived conclusions and looks upon Hindenburg as the one and only stabilizing influence at present in the possession of Germany.

The book also presents a very able description of the political events, with their causes and results, which have occupied the German mind since the gloomy days of 1918. Hindenburg is not infallible, he made mistakes, not of the mind but of the heart, and the more one studies the events surrounding these later years of his life the more one recognizes the lofty character of Germany's grand old man.

The Stability of Smokeless Powder

(*Continued from page 415*)

THE above considerations lead to the following general conclusions:

1. If we were concerned only with chemically pure cellulose nitrate or new powders made from it alone, the stability could be determined as accurately at one temperature as another. And further assuming proper standardization of all the tests at different temperatures, any one of the tests could be used to prove whether a given sample possessed the maximum stability.

2. But since we are concerned with measuring the degree of stability possessed by samples of slightly impure cellulose nitrate or powders made from such or powders which have decomposed to some extent during storage, the tests made at different temperatures cannot be expected to agree with precision.

This conclusion is borne out if consideration is given to the behavior of nitroglycerin-cellulose nitrate powders as compared to those containing cellulose nitrate alone. In the standard 135° C. heat test a normal nitroglycerin powder will change the color of the test paper in 20-25 minutes while

a normal cellulose nitrate powder will not give the color change until 90-100 minutes. At lower temperatures, however, 50° C. for example, there is no appreciable difference in the time required to produce decomposition of the two types of powder. This means simply that the rate of decomposition of the nitroglycerin-cellulose nitrate powder is greater at a given temperature than it is with the straight cellulose nitrate powder; this difference is marked at 135° C. but at considerably lower temperatures the rate is so low with both powders that no appreciable difference in their behavior is observed. The situation is similar when stability tests at different temperatures are applied to cellulose nitrate powders which contain impurities having widely different rates of reaction with the nitrate at the different temperatures.

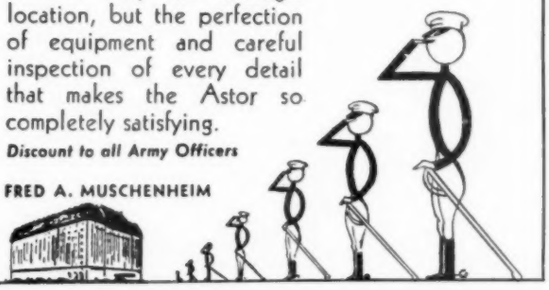
Hotel Astor
TIMES SQUARE NEW YORK CITY

INSPECTION

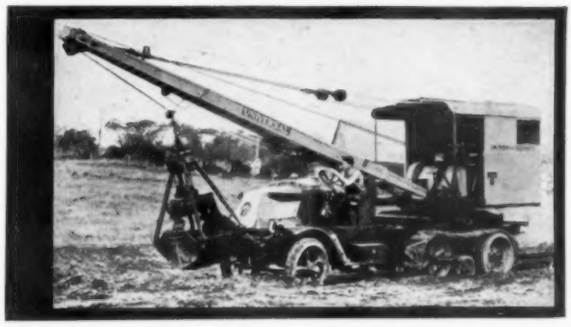
It isn't only the strategic location, but the perfection of equipment and careful inspection of every detail that makes the Astor so completely satisfying.

Discount to all Army Officers

FRED A. MUSCHENHEIM



5-6-7½ TON



TRUCK-CRANES

UNIVERSAL TRUCK CRANES are mounted on motor trucks for speedy mobility—they are always loaded and ready to go—and may enjoy the additional mobility advantages of the Christie Crawler.

UNIVERSAL CRANE COMPANY
Lorain, Ohio

UNIVERSAL

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ARMY ORDNANCE

VOLUMES I TO XI, INCLUSIVE
Compiled by
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Department of Mechanism and Drawing
University of Michigan

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Both prices f. o. b. Washington, D. C.

Address Orders to:
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Mills Building, Pennsylvania Ave. at 17th St.,
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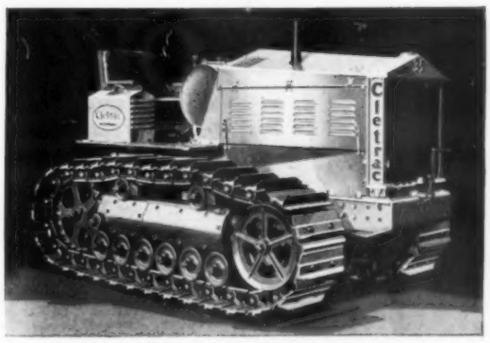

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CRAWLER TRACTORS

A COMPLETE LINE OF FIVE SIZES-15 to 83 H. P.

High power efficiency at draw-bar—sure-grip traction—power steering—continuous gravity oiling—dust-proof bearings.

Write for Catalogs and Specifications

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Time and money saving models for printing, typewriting, composing, addressing and folding. Sales and service offices in fifty cities.

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Years of experience plus ample facilities for manufacturing mean Quality and Service. A background of 128 years in the metal industry, combined with three million square feet of floor space, modernly equipped, qualifies Scovill Manufacturing Company to meet high speed production demands for both mill and manufactured goods of Brass, Bronze, and Nickel Silver and of other metals.

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UNITS OF
Union Carbide and Carbon Corp.

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How can your conscience be clear when you know that your automobile brakes are not in perfect working order? You can have your brakes inspected free of charge at any RUSCO Service Station. It only takes a few minutes. If relining is necessary, be sure to specify RUSCO. Rusco Brake Linings are always dependable.

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(Incorporated 1834)
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No Matter where you are posted

a Crane branch is near you

NINE Crane factories manufacture every type of plumbing and heating fixture, valve, fitting, or piping specialty you require.

One hundred and seventy strategically located branches hold these materials ready for delivery.

This completeness of line and completeness of distribution service insure for you the elimination of time loss as well as the satisfaction of Crane quality in materials on any army engineering job—whether it is as big as the Panama Canal or as small as the erection of temporary officers' quarters.

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ARCHITECTS: HOLABIRD AND ROOT CHICAGO

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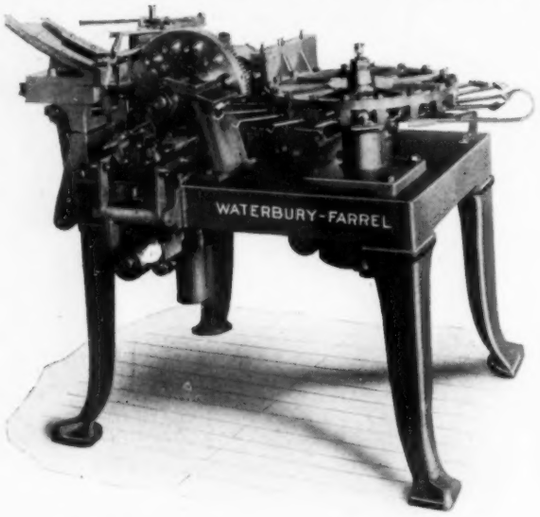
A·O·SMITH CORPORATION
GENERAL OFFICES: MILWAUKEE, WISCONSIN

GAUGING and WEIGHING



.30 CALIBER CARTRIDGE CASES

This semi-automatic machine will gauge and weigh loaded cartridges, or gauge unloaded, primed cases. Hourly production at 70 per cent efficiency, 2100.

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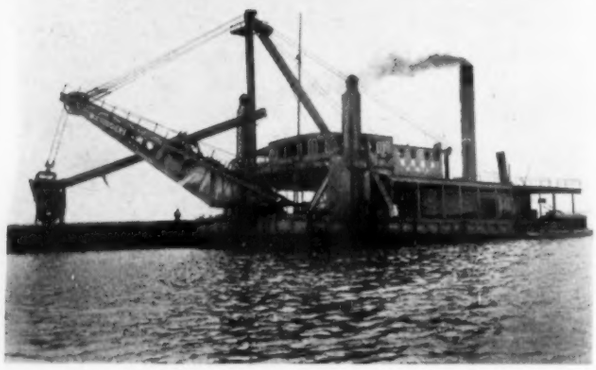
Studebaker also builds the world's lowest priced 2-ton chassis ($895 at the factory) and the lowest priced 3-ton chassis in the world ($1350 at factory).

STUDEBAKER TRUCKS

Studebaker's gain of 127% in United States registrations last year when the industry lost 23% was due to outstanding VALUE.

The reliability, long life and trouble-free operation of the complete line of Bucyrus-Erie dredges is available for your job. This manufacturer of the world's largest dipper, hydraulic and mining dredges, offers equipment that assures you maximum production with minimum unit cost.



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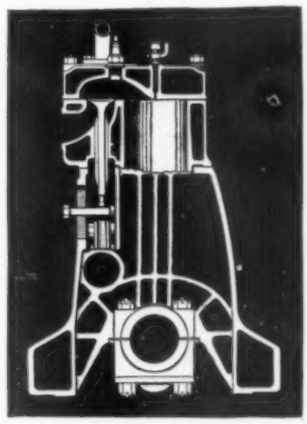
LAWN AND GARDEN FERTILIZER — "LŌMA"

Tennessee Corporation

61 BROADWAY NEW YORK CITY

STRONG AND DEEP



"Girder" Crankcase

Waukesha's "girder" type crankcase is designed for extra rigidity, both in bending and in torsion. The steel backed bearing caps are held by four heat-treated alloy steel stud bolts. Reciprocating parts are closely paired and accurately balanced. Not only is objectional vibration thus eliminated but the combining of "girder" crankcase, rigid bearing and crankshaft construction is an exclusive Waukesha feature that makes double flywheels or dampeners unnecessary.

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The New Noiseless

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NEW accumulator dials—positive or negative, new keyboard construction, new clearance and shift, new half-cent and split dials, are features that save countless, costly operations in figuring.

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Estoppey Type D-4 Bomb Sight

This type Bomb Sight is now being used by the U. S. Air Corps. Full details will be furnished on request.

Prompt delivery can be made from stock.

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"Standard" PLUMBING FIXTURES

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INSIGNIA
OF
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THE medal of the Army Ordnance Association is suspended on the traditional Ordnance colors: crimson bordered with yellow and piped with black. The medal itself is struck from bronze of unusual historical significance. This material was used in a 6-inch howitzer of British manufacture which was captured by the German Army during the World War on the Russian front. Reconditioned by the Germans, the gun was put into service by them in the Argonne where it was captured by the 77th Division, American Expeditionary Forces. As shown in the accompanying illustration, the medal has on its obverse side the United States eagle and shield, the flaming bomb of ordnance and a superimposed scroll of the Association. The ribbon is of best quality grosgrain silk 1⅜ inches in width attached to a hidden bar pin with safety catch. The medal and ribbon are authorized for wear on the uniform in accordance with Army Regulations 600-40. All insignia of the Association are designed and manufactured by the well-known firm of medalists, Messrs. Bailey, Banks and Biddle of Philadelphia.

The Medal

Price boxed $1.00

The Emblem

The emblem of the Association for wear on the lapel of civilian dress, is furnished in bronze and 14 kt. gold. It is ⅝-inch in diameter and has on its face the ordnance bomb in black and crimson with the name of the Association on the outer edge.

Emblem in 14 kt. gold $3.50

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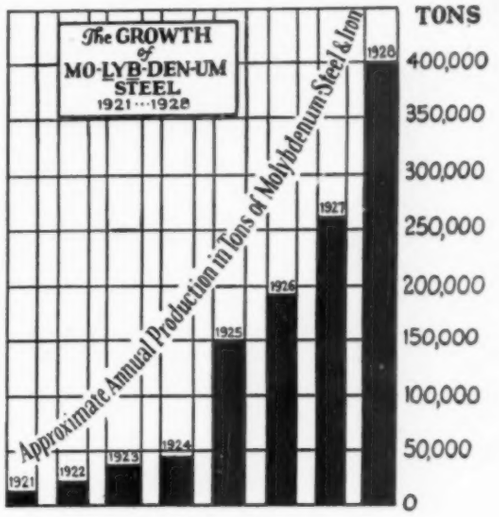

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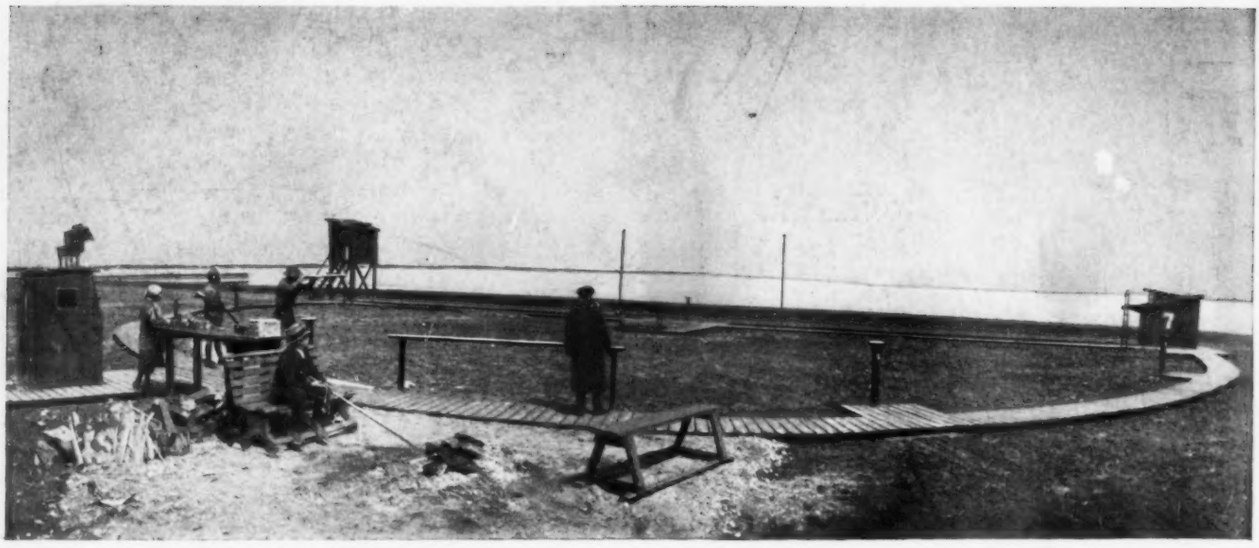

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